University of Alberta

A Paleoethnobotanical Investigation of Gården Under Sandet, a Waterlogged Norse Farm Site, Western Settlement, Greenland (Kalaallit Nunaata)

by

Julie Megan Ross ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial
fulfillment of the requirement for the degree Masters of Arts

Department of Anthropology

Edmonton, Alberta

Fall 1997

National Library
of Canada

Acquisitions and
Bibliographic Services

395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque nationale
du Canada

Acquisitions et
services bibliographiques

395, rue Wellington
Ottawa ON K1A 0N4
Canada

Your file Votre référence

Our file Notre référence

The author has granted a non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of this thesis in microform, paper or electronic formats.

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de cette thèse sous la forme de microfiche/film, de reproduction sur papier ou sur format électronique.

The author retains ownership of the copyright in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

L'auteur conserve la propriété du droit d'auteur qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

0-612-22551-8

Canada

University of Alberta

Library Release Form

Name of Author: Julie Megan Ross

Title of Thesis: A Paleoethnobotanical Investigation of Gården Under Sandet, a Waterlogged Norse Farm Site, Western Settlement, Greenland (Kalaallit Nunaata)

Degree: Master of Arts

Year this Degree is Granted: 1997

Permission is hereby granted to the University of Alberta Library to reproduce single copies of this thesis and to lend or sell such copies for private, scholarly or scientific research purposes only.

The author reserves all other publication rights and other rights in association with the copyright in the thesis, and except as hereinbefore provided, neither the thesis nor any substantial portion thereof may be printed or otherwise reproduced in any material form whatever without the author's prior written permission.

Julie M Ross

156 Quesnell Crescent
Edmonton, Alberta
Canada
T5R 5P3

October, 3 1997

University of Alberta

Faculty of Graduate Studies and Research

The undersigned certify they have read, and recommend to the Faculty of Graduate Studies and Research for acceptances, a thesis entitled A Paleoethnobotanical Investigation of Gården Under Sandet, a Waterlogged Norse Farm Site, Western Settlement, Greenland (Kalaallit Nunaata) submitted by Julie Megan Ross in partial fulfillment of the requirements for the degree of Masters of Arts.

Charles Schweger

Charles E Schweger

A Beaudoin

Alwynne Beaudoin

Clifford Hickey

Sept. 29, 1997

Michael Hickman

Michael Hickman

Abstract

Gården Under Sandet, GUS, is a Norse age central farmstead in the Western Settlement of Greenland. Archaeobotanical samples were collected during the 1995 and 1996 seasons; 42 of the 139 samples collected were analyzed. The archaeobotanical remains are excellently preserved because the site was sealed by alluvium and permafrost.

The Western Settlement was established by the Norse in ca. AD 1000; the Greenlandic economy of the times was based on animal husbandry and hunting. The Norse relied on infields and outfields to provide fodder and construction material resulting in a heavy reliance on vegetation. The abandonment of the Western Settlement (ca. 1350) may have been caused by many factors but of those suggested only caterpillar attack, climate change and non-sustainable land-use practices could influence the archaeobotanical assemblage.

Norse archaeobotanical assemblages are created by dynamic formation processes which must be carefully determined. To avoid formation processes resulting in general interpretations a specific sampling is suggested and should be implemented.

Samples from the long house may indicate use of different fuels. A few anthropochores present in these samples indicate that the vegetation was quickly changed. Anthropochores later dominate the samples indicating weeds became prolific. Analysis of manure showed cows ate Grass or Heath/Outfield plants and caprines grazed on Heath/Outfield plants or on plants from mixed groups.

Acknowledgments

The list of people that I would like to thank is enormous as a research project such as this, although having only one author, would not have been possible without all those mentioned below and more.

I would like to thank the Canadian Circumpolar Institute (CCI) and the Canadian Institute of Nordic Studies (CINS) for their financial support directed at the paleoethnobotanical aspect of the GUS project. My advisor Dr. Charles Schweger, and my committee members Dr. Alywnne Beaudoin, Dr. Cliff Hickey and Dr. Michael Hickman all deserve a thank you for the time they invested in my Masters thesis and my education. I would like to thank Dr. Cynthia Zutter for acting as an unofficial advisor while Dr. Schweger was on sabbatical and for always asking the most difficult questions.

I will always hold Sven Erik Albrethsen, Jette Arneborg, Joel Burglund, Ditleve Mahler and Guðmunder Ólafsson dear to my heart for welcoming me to the GUS excavation and teaching me about Norse archaeology. They were also supportive in the post excavation research and making my stay in Copenhagen during the autumn and early winter of 1996 enjoyable.

My research opportunity in Denmark facilitated by CINS and Bent Aaby provided me with the opportunity to learn more about paleoethnobotanical research from Ole Benike, Bent Fredskild, Jan Andreas Harild, Annine Moltsen, Peter Rasmussen and David Robinson. From this long list I must single out Bent Fredskild for allowing me to use some of his Greenlandic reference material and David Robinson for his utter support while I was in Copenhagen and his continued long distance support. In a less academic but still crucial manner I would like to thank all the staff at NNU and those people who made my stay in Copenhagen fun (Aoife Daly, Niels Bonde, Jette Raal Hansen, Iva Koulbuhous, Susan Mahler, Kirsten Nersting, and "my Danish family").

Closer to home I would like to thank Harvey Friebe and Pam Manye-Correia for support in the labs and for their ability to always place the thesis work in perspective. Darlene Bagstad, Gail Mathew, Kelly Nicholson-Scheer and Marlus Rudiak in the Anthropology Office made all the difference in dealing with university matters that were not, necessarily, directly related to my thesis. An apology is owed to all volunteers who helped me Donna Cancilla, Anita Ross, Rodricko Loyola, Kenza Kahrim; I am sorry I can only thank you and not reward you financially. I am not sure when my thesis would have been completed without Joseph King who lent me a power book which made all the difference in my productivity making it possible for me to use every available moment.

Lisa Mutch, Rita and Jim Ross acted in a dual capacity as both editors and emotional support for which I am indebted. I am both lucky and thankful to have a dedicated and faithful core of friends, Megan Lappi, Mike MacKinnon, Erin McCloskey, Jill Norse, Denise Parson, Alineen Rhodes anf Klodyne Rodney who support me throughout the degree.

Perhaps not traditional but I would also like to thank Clare Anderson at the Sidetrack Cafe who in an indirect manner helped me achieve my academic goals.

Contents

1) Introduction 1
    Discovery of Gården Under Sandet 2
    Paleoethnobotanical Potential 3

2) History of Norse Greenland 5
    Introduction 5
    Eirik the Red's Banishment 6
    Norse Settlement of Greenland 7
    Expansion to the Western Settlement 9
    Historical Developments 11
    Agricultural Economy 13
        Animals 15
        Animal Shelters 16
        Infield/ *Tun* 18
        Outfield 25
        Wild Animal Resources 27
        Division of Subsistence Activities 30
    Abandonment 37
        Caterpillar Infestation 38
        Climate 40
        Non-Sustainable Land-Use Practices 43

3)Site Description 46
    Geographic Location 46
    Vegetation History of Western Greenland 49
    Vegetation Communities at GUS 53
    Archeological Data from GUS 56

4) Archaeobotanical Methods 60
    Samples in Relation to Sampling Universe 60
    Archaeobotanical Field Methods 61
    Archaeobotanical Laboratory Methods 62
    Pollen 64
    Grouping of Data 65

5) Results 67
    Macroremains 67
        Long House 69
        Living Rooms 73
        Animal Rooms 79
        Manure 84
        Construction Materials 83
    Pollen 85
        Room 3 85
        Manure 85

6)Formation Processes and Discussion 89
    Formation Process 89
        Factors Affecting Archaeobotanical Assemblages 89
        Formation Processes of GUS Archaeobotanical Assemblage 94
        Problems with Paleoethnobotanical Records 97
        Waterlogged Sites 99
        Identification of Formation Processes at GUS 101
        Archaeobotanical Sampling Strategies 103
    Discussion 108
        Long House 109
        Living Rooms 113
        Animal Rooms 116
        Manure 118
        Construction Material 120
    Demonstrating Strategy Five 122

7) Summary 130

Bibliography 138

Appendices 155

1 Norse Sites with Paleoethnobotanical Data 155
2 Macrofossils Identified at GUS and Other Norse Greenlandic Archaeological Sites. 156
3 List of Archaeobotanical Samples Collected from GUS 159
4 SEM Photographic Documentation (X30) and Identification Criteria of GUS Macrofossils 164
5 Macrofossil and Pollen Counts for GUS Samples 175
6 Common English, Danish and Greenlandic Names for Plant Found at GUS 191
7 Guidelines for Interpreting Paleoethnobotanical Assemblages 193
8 Plants Identified in GUS Samples with Known Anthropogenic Uses. 194

Tables

Table		Page
1	Palaeovegetation zones of the Godthåbsfjord area	50
2	Relative ages of sample based on room construction	67
3	Caprine and cow manure	81
4	Benefits and limitation of five strategies to eliminate "noise"	104

List of Figures

Figure		Page
1	Greenland and other areas of Norse influence	6
2	Map of Greenland	10
3	Broken millstone from Gården Under Sandet	19
4	*Rumex acetosella* in modern field near Igaliko (Garðar)	21
5	Irrigation channel at Garðar	23
6	Hypothetical Norse seasonal round (Western Settlement)	30
7	Hypothetical division of labour based on gender for Greenlandic Norse farm (Western Settlement)	33
8	Spade with a possible woman's marker	36
9	1995 Lush vegetation in valley behind GUS site	39
10	1996 Vegetation in valley behind GUS site following caterpillar attack	39
11	Map of Western Settlement	48
12	GUS in landscape	49
13	North and south facing slopes near GUS.	54
14	Mountain slope behind camp.	55
15	Highland meadow areas near GUS.	55
16	Sparsely vegetated sandy areas	56
17	Construction phases and room numbers	59
18	Archaeobotanical samples analyzed in reference to grid	61
19	Room 27, long house, pie diagrams for samples 3167, 3039, 2727 and 3216	70
20	Room 27, long house, pie diagram for sample 2830	71
21	Room 27, long house, pie diagram sample 2823	71
22	Room 27, long house, pie diagram sample 3160 (construction layer)	72

List of Figures

Figure		Page
23	Room 27, long house, pie diagram for sample 3264 (grass)	73
24	Building phase 4, pie diagrams for samples 2602/Rm6 and 2484/Rm4	74
25	Building phase 5, pie diagram for sample 2266/Rm4b	75
26	Building phase 6, pie diagrams for samples 2267/Rm1, 2283/Rm4a and 2450/Rm7	76
27	Room 19, pie diagram for sample 2624	77
28	Room 19, pie diagram for sample 2604 (posthole)	78
29	Unknown room, pie diagram for sample 2417	78
30	Room 3, cow byre, pie diagrams for samples 2544, 2470, 2424, 2610, 2609 and 2425	80
31	Caprine, pie diagrams for samples 3264/Rm27 and 2586/Q	82
32	Cow, pie diagrams for samples for 2456/P	82
33	Construction material, pie diagrams for samples 2334/Q, 2343/Q, 2319/Q and 2618/G	84
34	Room 3, Cow byre, pie diagrams samples 2463, 2464 and 2465	86
35	Caprine , pie diagrams for samples 2586/Q, JR9.96/Rm16, JR13.96/Rm16, 3229/Rm23, 3297/Rm25 and 3158/Rm27	87
36	Cow, pie diagrams for samples Sch8.7.96.4/Rm4, 3454/Rm19, Sch10.7.96.2/Unknown and JR20.96/Rm16	88
37	Five stages in formation of an archaeobotanical assemblage through time	91
38	Processes of introduction and uses of botanical material in a Norse Greenlandic site	95
39	Stylized drawing illustrating the generalized plant use of Norse in Greenland	96
40	Formation processes operating at GUS, post-abandonment and pre-burial of site	102

List of Figures

Figure		Page
41	Alteration between Wetland and Heath/Outfields groups in floor layers	111
42	Sources of botanical remains and formation processes in a Norse Greenlandic byre	123
43	GUS samples associated with formation process of a Norse Greenlandic byre	124
44	Paleoethnobotanical remains from type one samples combined to contrast the paleoethnobotanical remains of the byre a type two sample	124
45	Pie diagrams of GUS samples used to demonstrate Strategy Five	127

CHAPTER 1 INTRODUCTION

This thesis is a paleoethnobotanical study of archaeobotanical remains from a waterlogged Norse farm, Gården Under Sandet, in the Western Settlement of Greenland. This paleoethnobotanical investigation stresses the significance that site formation processes and sampling strategies have on interpreting waterlogged Norse Greenlandic sites. The Norse Greenlandic settlers practiced an agricultural economy based on pastoralism for approximately five hundred years. Pastoralism relies on the vegetation resources locally available and at this most basic level the Norse were dependent on the quantity and quality of plant resources available locally and regionally. The fundamental place held by plants in the Norse economy makes paleoethnobotanical investigation a priority within the context of Norse Greenlandic archaeology.

In this thesis, I will first provide a historical context by reviewing the discovery, settlement, historical development, agricultural practices and abandonment of Norse Greenland. The archaeological site of Gården Under Sandet, the vegetation history of Western Greenland and the vegetation found around Gården Under Sandet will be described, followed by the archaeobotanical field and laboratory methodologies used in this study and the results. Chapter 6 deals with the site formation processes responsible for the addition (input) and removal (output) of archaeobotanical remains at Gården Under Sandet. An investigation of these processes makes it apparent that waterlogged sites need to be approached with a new sampling and interpretation methodology because paleoethnobotanical methodology as applied to carbonized botanical remains are inadequate for waterlogged sites. I have attempted to define a new approach to sampling. The results of the paleoethnobotanical investigation of Gården Under Sandet are discussed in light of formation processes and situations where interpretation could be improved by implementing this new sampling strategy are indicated. The last section of chapter 6 is a limited demonstration of how the new sampling strategy can be applied using the byre from Gården Under Sandet. The final chapter summarizes some of the key points of the thesis and suggests what future questions might be investigated.

1.1.0 Discovery of Gården Under Sandet

The archaeological site known as Gården Under Sandet (GUS) was discovered during the summer of 1990 by Hans Jensen and Ole Lynge while hunting in the upper Ameralla Fjord area, western Greenland, inland from Nuuk (Arneborg and Berglund 1993; Kapel 1991). Jensen and Lynge discovered timbers and animal droppings eroding out of the bank of a meandering river. Staff of the Greenland National Museum and Archives confirmed it to be a Norse farmstead and named it Gården Under Sandet which translates from Danish to the Farm Beneath the Sand, reflecting the fact that the site is buried beneath about 1 metre of alluvial sand and gravel. Test excavations were carried out in 1991 by Claus Andreasen, then of the Greenlandic National Museum and Archives, and Jette Arneborg of the Danish National Museum. Full-scale excavations were conducted during the summers of 1992, 1993, 1994, 1995 and 1996 over a four week period of opportunity between snow melt and the rise of the river. Excavations have been carried out with a degree of urgency as the high summer river levels flood and erode the site. Without total excavation in a few years nothing would remain of GUS for future research.

1.2.0 Paleoethnobotanical Potential

An invitation to Dr. Schweger, University of Alberta, to carry out paleoecological and geoarchaeological research at GUS, led to my participation in the field work during the summers of 1995 and 1996. It was recognized early on that GUS had tremendous potential for paleoethnobotanical studies which involve the interpretation of archaeobotanical remains found in sediments (Popper and Hastrof 1988). Analysis of samples collected during the 1995 and 1996 field seasons forms the basis of this thesis.

The type of questions which can be asked of the GUS archaeobotanical material differs from those asked of many Norse age farms both outside and inside Greenland. This is due to the plant resources available to the Norse, extensive site excavation, sampling techniques applied and excellent preservation of the archaeobotanical material. Norse Greenlandic plant use differed from Norse plant use in other regions of the North Atlantic due to the cold Greenlandic climate and the limited diversity of plants which grow there. Samples taken from GUS also differ from samples collected at other Greenlandic sites. First, because of river erosion GUS was totally excavated. Typically, excavation of Norse farms has been confined to the surface building in order to preserve the Norse marker on the landscape (Krogh 1967). This means samples from GUS are associated with early and later periods of farm development. Second, the paleoecological record of Greenland has been established through the coring of bogs and lake sediments or transects dug near archaeological sites. This paleoecological data is used to extrapolate the changes in vegetation during the Norse period. In only four cases have samples been taken directly from archaeological features: Niaquassat (V48) (McGovern *et al.* 1983), Nipáitsoq (V54) (Buckland *et al.* 1983), Narssaq (Fredskild 1973) and Sandnes/Kilaarsarfik (Fredskild and Humle 1991) (Appendix 1). Because the GUS site was buried beneath alluvium and frozen into permafrost a wider range of archaeobotanical remains were preserved in what is essentially a waterlogged state compared to other Norse Greenlandic sites (Appendix 2). Waterlogged sites are relatively uncommon within the realm of paleoethnobotanical investigations which are normally based on carbonized material (Miksicek 1987). Waterlogged sites are common, however, for Viking age or later urban sites in Denmark (Robinson and Mikkelsen 1993). Due to these factors Gården Under Sandet provides an exciting opportunity to investigate Norse plant use.

CHAPTER 2 HISTORY OF NORSE GREENLAND

2.1.0 Introduction

Greenland was discovered and settled by Eirik Thorvaldson (Eirik the Red) and his followers in the later years of the tenth century A.D. The Norse Greenlanders prospered as farmers and hunters and interacted with the larger Scandinavian culture and the European economic and political community from AD 1000 to 1500 (Figure 1). By ca. A.D. 1500 Greenland was abandoned by the Norse.

The history of Norse Greenland, as revealed by archaeology, started to come to light in A.D. 1880 when Gustav Holm surveyed Julianehåb (Qaqortoq) (Albrethsen 1991). Since then, many studies have illuminated the life of the Norse in Greenland, including Daniel Bruun's investigation of Julianehåb and Godthåb (Nuuk) in A.D. 1894 and 1903, respectively; Poul Nørlund's 1921-1932 work; and the investigations of Aage Roussell and Christain L. Vebæk. The next period of Norse research in Greenland occurred after 1964 (Albrethsen 1991), and in the 1970s and 1980s with the Nordic Archaeological Project of 1974-1977, and the Inuit/Nordbo project (Albrethsen and Keller 1986; McGovern 1980, 1991). In addition to archaeological evidence, our knowledge of Greenland's Norse history comes from the sagas, fragmented historical texts and letters, the *Landnámabók* (The Book of Settlement) and Grønlands historiske Mindesmærker I-III of 1834 (Albrethsen 1991).

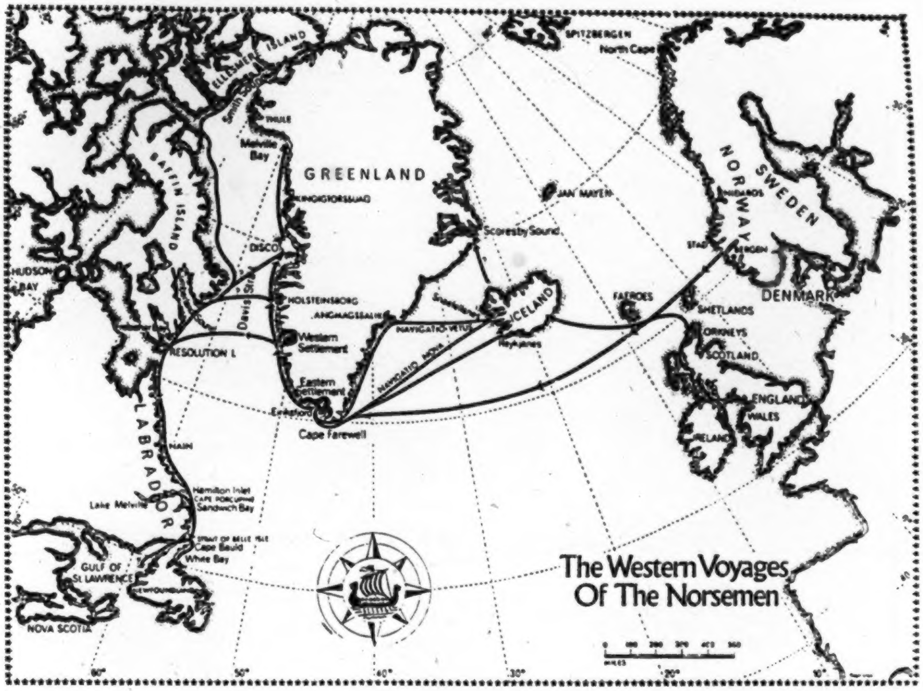

ELLESMERE ISLAND
Smith Sound
THULE
Melville Bay
GREENLAND
BAFFIN ISLAND
DISCO
HUDSON BAY
Davis Strait
HOLSTEINSBORG
ANGMAGSSALIK
Western Settlement
RESOLUTION I.
Eastern Settlement
Eiriksfiord
Cape Farewell
NAVIGATIO VETUS
NAVIGATIO NOVA
LABRADOR
NAIN
Hamilton Inlet
CAPE PORCUPINE
Sandwich Bay
Lake Melville
STRAIT OF BELLE ISLE
Cape Bauld
White Bay
GULF OF ST LAWRENCE
NEWFOUNDLAND
NOVA SCOTIA
SPITZBERGEN
North Cape
JAN MAYEN
Scoresby Sound
ICELAND
Reykjanes
FAEROES
NORWAY
SWEDEN
NIDAROS
STAD
BERGEN
DENMARK
SHETLANDS
ORKNEYS
SCOTLAND
ENGLAND
WALES
IRELAND
The Western Voyages Of The Norsemen
0 100 200 300 400 500
MILES
60°
50°
40°
30°
20°
10°

Figure 1. Greenland and other areas of Norse influence
Reprinted by permission, Jones 1987, *History of the Vikings* Oxford University Press.

2.2.0 Eirik the Red's Banishment

According to *Landnámabók* banishment twice forced Eirik the Red to relocate. Eirik's father, Thorvald Asvaldson, was banished from Jæren, situated south of Stavanger, Norway, because of manslaughter. Father and son traveled to Iceland, and settled on Drangar at Hornstrandir in Northwest Iceland in approximately A.D. 970. Eirik married Thjodhild, daughter of Jorund Atlason and Thorbjorg Knarrarbringa (Book of 1972; Bruun 1918) and in order to improve their situation proceeded to relocate a number of times. A misunderstanding between Eirik the Red and his neighbor, Thorgest Gamli, resulted in blows and ended with a number of people being slain. The district was divided as to whether Thorgest or Eirik was in the right and conducted a trial according to Icelandic law. Eirik lost his case and was banished from Iceland for three years (Book of 1972; Gad 1970; Nørlund 1936).

In A.D. 982, Eirik left Iceland and set out to explore what would become the westernmost settlement of the Viking period. He navigated westward, probably with prior knowledge of what lay before him. There had been tales of Gunnbjörn, the son of Ulf Kraka, who sometime between A.D. 870 to 930 was blown off course on his way from Ireland to Iceland, sighted islands west of Iceland which he named *Gunnbjarnar sker* (Gunnbjörn's skerries). These tales were well known in northwest Iceland where Eirik had lived, as Gunnbjörn's family had lived there (Book of 1972; Gad 1970; Nørlund 1936; Jones 1987). Encountering the coast of Greenland, Eirik the Red explored from what is modern day Semersôq Island to Ikersaauaq in the north. This includes the modern-day principalities of Cape Farwell (Nanortalik), Julianehåb, and Narssaq (Gad 1970).

2.3.0 Norse Settlement of Greenland

Eirik returned to Iceland before the winter of A.D. 985-986 to make arrangements to colonize the new land that had made such a remarkable impression on him during his banishment. His enthusiasm, and the dissatisfaction of many with their lives on Iceland, enabled Eirik to fill twenty-five vessels and set sail for Greenland in the summer of A.D. 986. Most of the Icelanders who abandoned their homes were from overpopulated areas in Breidifjord and Borgarfjord. Many of these men owned poor quality land or were relatives of Eirik and looked to improve their situation. But not all the emigrants to Greenland were of poorer social standing. The *Landnámabók* mentions Herjolf Bardarson who left good land in Iceland on which three generations of his family had lived to follow Eirik (Book of 1972; Gad 1970; Jones 1987).

Upon arrival in Greenland, the first settlers took possession of the best fjords. Competition for these fjords may have been less than anticipated since only fourteen of the twenty-five vessels that set out arrived in Greenland. These ships met with a storm, some ships turned back and others were lost at sea. The storm was so great that it warranted mention in a poem which was eventually included in the *Speculum Regale*, a Norwegian work written about A.D. 1250 (Gad 1970; Jones 1987). Nine men are listed in *Landnámabók* (Herjolf, Ketil, Hrafn, Solvi, Hegi Thorbrandsson, Thorbjorn Glora, Einar, Hafgrim, Arnlaug) as taking possession of fjords in the Eastern Settlement (Book of 1972). The lands claimed by Eirik's family included Brattahilð, owned by Eirik; Garðar (later the Bishop's seat), settled by Eirik's daughter, Freydis and her husband Thorvard; and Hvalseyjarfjord settled by Eirik's cousin, Thorkel Farserk (Book of 1972; Jones 1986; Magnusson and Pálsson 1965; Gad 1970). Settlement of southwestern Greenland, which has come to be known as the Eastern Settlement, continued until eventually it included a cathedral, a Benedictine convent, an Augustinian monastery, twelve parish churches and between 190 to 220 farms of varying sizes (Jones 1986, 1987; Krogh 1967; Vebæk 1991b).

2.4.0 Expansion to the Western Settlement

Expansion into the Western Settlement, 575 km (McGovern 1980) northwest of the Eastern Settlement, may have occurred during the original *landnám*. The account of settlement in the *Landnámabók* mentions that after the eastern fjords were settled men went west and settled (Figure 2). According to the saga accounts families were living in Lysu Fjord (Ameralik Fjord) by A.D. 1005 (Gad 1970). Archaeological evidence supports this claim as a house under ruin number V52a in the Western Settlement is dated by architectural criteria, being similar to construction at Brattahilð, to the earliest *Landnám* period (Gad 1970). The Western Settlement appears to have also prospered eventually growing to about 90 farms and 4 churches, the most important being Sandnes (Jones 1987).

Three more emigrations to Greenland occurred between A.D. 986 and 1000, as word spread about the good living conditions along the coast of Greenland. The Norse population of Greenland at its height is thought to have ranged from a conservative estimate of about 2,250 people (Lynnerup 1996) to about 6,000 (Jones 1987; Krogh 1967; McGovern 1985, 1991; Nørlund 1936). The first two centuries of expansion saw the smaller and more remote valleys behind the fjord heads settled, as well as a Middle Settlement which includes the modern municipalities of Ivigtut and part of Frederikshåb (Albrethsen and Keller 1986; Gad 1970;). Settlement probably followed both a chronological and socially dictated pattern (Christensen-Bojsen 1991a) where the first settler with the highest status obtained the best lands and later arrivals or those of lower status were relegated to smaller, less ideal allotments.

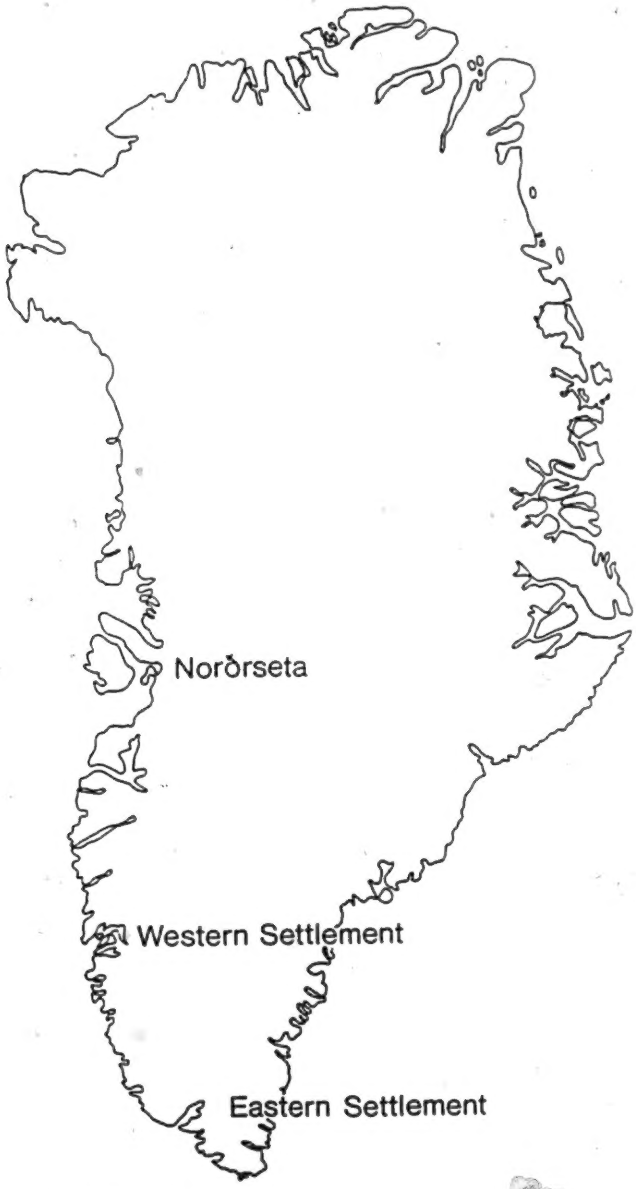

Norðrseta
Western Settlement
Eastern Settlement

Figure 2. Map of Greenland.
Western Settlement includes Sandnes, GUS, Austmannadalen, Niaquassat, Nipáitsoq, Eqalugialik, Ujarassuit and Umiviarssuk.
Eastern Settlement includes Gar∂ar, Brattahil∂, Isafjord, Hvalsey, Undir Höfdi and Narssaq.
Reprinted by permission, Jette Arneborg 1991, *Acta Borealis*

2.5.0. Historical Developments

Although Norse Greenland was the most westward European settlement at that time, the settlers were not immune to European social, economic, and political developments. According to *The Story of Einar Sokkason* (Krogh 1967), Sokki Thorisson who was the chief at Brattahild called a *thing* (meeting of landowners) and suggested a bishop's see should be obtained for Greenland. The Norse Greenlanders agreed and Einar Sokkason (Sokki's son) was sent to Norway with gifts, including walrus tusks, skins and a live Polar bear for King Sigurd Jerusalem-farer, who arranged for the consecration of the Bishop of Greenland (A.D. 1124). Einar Sokkason and the newly consecrated Bishop Arnald arrived back in Greenland A.D. 1126 (Krogh 1967). The appointment of a Bishop not only required a significant price in terms of the gifts presented to the King, but also a continued commitment to support a Bishop and his entourage in Greenland, and the additional economic burden of taxes to be sent to Rome. The costs associated with a Bishop appears to have been high for a small community.

Greenland, like its motherland, Iceland, came under the rule of Norway in A.D. 1261 (Magnusson and Pálsson 1965), but this political agreement by no means led to security of trade and contact with Europe for Norse Greenland. Included in the agreement which subordinated Greenland to the Norwegian crown were conditions that the Crown was to send two ships a year to Greenland. There is no record of any ships much less two a year reaching or departing for Greenland from Norway after A.D. 1367 (Gad 1970). One of the reasons for the reduction of trade may have been the Black Death which started in Norway in A.D. 1349 (Keller 1991). Not only did the plague decrease the number of people to the point where there may not have been enough people to make dangerous voyages to Greenland (Gad 1970) but a tax (*sekkjagjald*) of one twelfth of all their business done which was to be paid in advance to the Norwegian Crown must have deterred the merchants who could have made the voyage after A.D. 1382 (Bruun 1918; Gad 1970; Jones 1986). The limited trade that occurred between Norway and Greenland can be attributed to a distant and uncaring ruling crown (Magnusson and Pálsson 1965).

In addition to strict rules governing trade, the opening of continental trade routes, such as the one to Africa for elephant ivory, made the once valuable Greenlandic walrus ivory no longer worth the treacherous voyage to Greenland (Jones 1987). Not only was the ivory trade taken away from Greenland but the previously highly valued homespun (cloth) that came off the Norse women's looms was replaced by cloth from England and the Netherlands. Also during this time the Russians were dominating the fur trade (Nørlund 1936) reducing the demand for Greenlandic fur and hides.

Through time, those who controlled the trading traffic between Greenland and Europe become more and more removed in both physical distance and kinship ties with Greenland. The Kalmar Union which united the Scandinavian countries in A.D. 1387 (Larsen 1950), probably augmented the Norsemen's problem of receiving enough ships from Scandinavia. The rulers who controlled trade were more concerned with the ruling of Scandinavia than the colonies attached to it (Jones 1986). But possibly the ultimate demise of trade between Norway and Greenland occurred when the Hanseatic League took control of trade between the Nordic counties and southern Europe. These German merchants had little or no interest in the North Atlantic Islands, likely because the dangerous sea voyage outweighed the possible profits (Gad 1970).

The importance of this trade to the daily survival of the Norse in Greenland may not have been essential. Krogh (1967) does not think the reduced frequency of vessels would have affected Norse survival, because even at the height of trade the Greenlandic farmsteads could not have depended on imports for their daily livelihood. The Norse farms were possibly self-sufficient and did not need this trade, which nevertheless must have been important in terms of maintaining political, religious and cultural connections.

2.6.0. Agricultural Economy

Norse Greenlandic agriculture has been explored by many researchers (Albrethsen 1991; Albrethsen and Keller 1986; Berglund 1986; Bruun 1918; Fredskild 1988, 1989, 1992; Krogh 1967; Nørlund 1936) but has not been synthesized or reconstructed as a functioning seasonal system. Many of the agricultural practices known from the larger Scandinavian community are assumed to have applied to Greenland. It is through the use of historical analogy, the study of historical documents, and the gathering of archeological and botanical evidence that the patterns of agriculture in Greenland have been developed.

The people who came to Greenland were farmers, as were the people who had earlier settled Iceland. Animal husbandry was important to the Norse Greenlander for dietary reasons, cultural identity, including status reckoning, and a sense of connection to the wider homogenous Scandinavian community. As pastoralists they primarily needed good pasture lands. It is the availability and productivity of the available pasture lands that determine the carrying capacity of the land for the livestock and therefore the people.

As pasture land was the most important resource, it influenced settlement patterns more than other resource, such as reindeer herds or, access to waterways for transport, or marine resources. This explains why inner fjord environments were settled, for it is here that the best pasture land is to be found. These interior environments experience a continental climate with sunny summers favorable for grass, herb and shrub growth. This is in contrast with the outer parts of the fjords which have a colder coastal climate with wind and rain (McGovern and Jordan 1982). The Norse settled the inner fjords in both the Eastern and Western Settlements. Situated closer to the outer coast the Eastern Settlement would have experienced less seasonal variation and because of its more southerly location enjoyed a longer but not necessarily warmer summer (Fredskild 1983a, 1992; McGovern 1991). However, the area's climate was influenced by drift ice. The Western Settlement is situated more inland and therefore has greater climate variation. Inland farms are often located very near the inland ice (Albrethsen and Keller 1986; Jones 1986; Krogh 1967; McGovern 1991) and therefore are subjected to increased frequency of föhn winds blowing off the ice (Hansen 1991).

In Greenland, animal husbandry requires year-round feed, particularly in the winter when animals particularly cows were kept in byres. Both supplying winter feed and byres have own problems relating to access to resources, scheduling of labour and combating natural elements. What we know of how the Norse solved these problems will be described below.

2.6.1. Animals

Norse farming was based on cattle, sheep, goats, horses, dogs and pigs (Vebæk 1991a). Cattle were the most important animal in terms of status but sheep and goats were relied on for daily subsistence. More attention had to be paid to cows not only because of their value as a status symbol but also because cows are more reliant on humans for food than the other animals. Cows needed to be wintered in a byre, thus structures and fodder are required. A cow eats roughly 4,200 to 4,400 kg of hay annually (Christensen-Bojsen 1991a; Hansen 1991). In addition, cattle need roughly 7 to 8 litres of water a day (Rasmussen 1989, 1993). The resources needed to supply the estimated 1,000 to 2000 cattle, suggested for the Vatnaverfi district (Jacobsen 1987), would amount to between 4,200,000 kg to 8,800,000 kg of fodder and 2,555,000 to 5,840,000 litres of water annualy or 11,507 to 24,110 kg of fodder and 7,000 to 16,000 litres of water daily. In general cattle required more than sheep.

Although not held in high esteem, sheep and goats, (here collectively referred to as caprines unless information is specifically directed at only one of the species) were important for the economy of the farmstead. This is attested by the quantity of weaving implement and caprine dung that have been found in Norse sites by excavators (Gad 1970). The caprines from the Western Settlement were not culled at a young age but were left to grow to maturity, the assumption being that the animals were more important for their secondary products, milk and wool in the case of sheep, than for their meat (McGovern 1984, 1992). Homespun, woven from spun wool, was a valuable domestic and export item. If sheep dropping were collected for fuel, as in Iceland, sheep provided another valuable secondary product

(Albrethsen and Keller 1986). The Norse sheep were of the "goat horned" breed, *Ovis aris*, and were hardy and able to survive out of doors all year. The presence of caprine droppings inside Norse Greenlandic structures could be evidence that at least some of the animals were wintered in doors (Gad 1970). During extreme weather conditions caprines might require stabling as well as supplemental fodder. Föhn winds can be both a help and a deterrent to caprines as the winds can remove and/or melt snow cover exposing vegetation for grazing. However, when föhn winds cease, the snow surface freezes to sheets of ice. Föhn winds can also bury a sheep in snow (Hansen 1991, Jacobsen 1987). Caprines will eat a wider variety of plant material than cows. A fertile ewe needs 700 kg of dry digestible matter a year (Christensen-Bojsen 1991a) and only requires 1 to 2 litres of water a day (Rasmussen 1989, 1993). For the Vatnaverfi district of the Eastern Settlement it is estimated that over 100,000 sheep and goats may have been pastured at the height of the Norse period (Jacobsen 1987). The resources these animals required included about 700,000,000 kg of hay and between 36,500,000 to 73,000,000 litres of water annualy or 1,917,808 kg of fodder and 100,000 to 200,000 litres of water daily.

2.6.2. Animal Shelters

The detail and care that was invested in constructing the byres and animal stalls to increase the warmth and durability of the buildings attests to the importance of the animals to the Norse farmers (Gad 1970). There was great care in byre placement and architecture. Most excavation reports comment on byre placement as being carefully considered for either the comfort of the animals (reduction of wind) or for the efficiency of labour (location with good drainage) (Roussell 1941; Vebæk 1943). Once constructed, the building would have to house animals for the winter which could last eight or nine months. Cows were placed in stalls where they either stood or lay down until the spring. The stalls were not likely to be cleaned often as the accumulation would provide insulation against the winter cold (Gad 1970; Roussell 1936) and a possible heat source as it decayed. There was constant accumulation (input) of botanical material to the byre floor as fodder was provided, bedding was added and some human fecal and cultural waste was disposed of (Robinson and Rasmussen 1989). It has been suggested that juniper or willow twigs might also have been scattered on the floor of the byre (Gad 1970; Roussell 1936).

The Bishop's farm at Garðar, based on size alone, was the highest status farm in Greenland. There were two cow byres, the larger was 63.5 m by 4.2 m and the smaller byre was a bit wider and 41.5 m in length (Gad 1970). If each cow was thought to receive a stall of about 1.16 m by 1.25 m (Christensen-Bojsen 1991b), 125 cows were byred giving Garðar by far the largest holding of cattle. For comparison, byres on other farms might have held anywhere from 3 to 8 cows (McGovern 1993a).

Byre walls were constructed of stones and turf, and "buttress mounds" were often used to secure the whole construction and in Greenland are thought to have also protected against the cold. The floors were paved with flatstone and a gutter ran down the center of the farm for the liquid manure to run out or collect in pits. Byre entrances were long, similar to Inuit house entrances, which would act to prevent cold from reaching the cows (Nørlund and Stenberger 1934).

The Norse built different types of structures for sheep including sheds, folds and cotes. Sometimes these are attached to the cow byre otherwise they are separate structures (Nørlund and Stenberger 1934). At Brattahilð a suggested washing fold is situated very near a water source; there are other folds at varying distances from the farm (Nørlund and Stenberger 1934). The variety of sheep related structures suggest that sheep had more specialized needs than cattle, although sheep are easier to feed than cattle. At Sandnes, the large church farm in the Western Settlement, a case to hold shears was found. Shears may or may not have been used for sheep as Greenlandic sheep likely shed their wool in which case it would have been just pulled off the animal or collected after being shed (Roussell 1936; Vebæk 1991b).

2.6.3. Infield/*Tun*

Previous studies indicate that it was impossible for cereal crops to be grown to maturity in Greenland (Hansen 1991). This explains why the *Speculum Regale* states that the people of Greenland did not know of bread (Bruun 1918; Hansen 1991; Krogh 1967). Domestic animals may have been the beneficiaries of attempts to grow grain for human consumption. The often cited single grain of corn pollen [Corn being an inclusive Europena term for *Hordeum*(barley), *Avena*(oats), *Triticum* (wheat) and *Secale* (rye)] from Thjodhid's church supports the *Speculum Regale*'s reference to attempts to grow grain (Krogh 1967). The inability to grow cereal crops successfully, such as barley which needs 1,050 annual effective temperature sum (ETS) of degree days at 5°C, left the Norse without bread and beer. For a plant species to complete a life cycle its ETS must exceed a critical level. The ETS is calculated by subtracting "the plant's threshold temperature from the mean daily temperature and summing up over the year" (Hansen 1991:44). The threshold temperature is the minimum temperature that must be reached for a specific plant to grow. Degree days, a commonly used measurement of accumulated temperature effects, are determined by calculating how many days the temperature was above the threshold temperature. For example, if the threshold temperature is 5°C and the temperature one day is 15°C the result is three degree days (Hansen 1991). Norse attempts at grain cultivation are supported by the *Speculum Regale* and the discovery of milling stones at Garðar, Undir Höfdi, Hvalsey Ø64c and GUS (Figure 3). These milling stones were either never used, used for imported grains, or used on locally grown grains, either cereal or wild crops (Arneborg and Berglund 1995; Scott and Halffman 1991; Vebæk 1943).

Figure 3. Broken millstone from Gården Under Sandet. Photo by Dr. C. Schweger.

Locally grown crops would have been restricted to pasture grasses, which only required 350 degree days above 4.4°C (Hansen 1991), obtained from the home fields and more distant meadows (Gad 1970). Hay making was the key activity that allowed farmers to maintain their cattle, perpetuate the family's status and provide a connection to the greater Scandinavian community.

The Norse either burned off or cut down the original vegetation to create infields which had to be fertilized, watered, tended, protected from the animals and harvested. The *Speculum Regale* reports "that the pastures is good, and that there are large and fine farms in Greenland." and "The earth yields good and fragrant grass" (Jones 1986:84). The Norse grass pastures have left a mark on the Greenland landscape that can be seen today. The lush vegetation that still grows on the infield areas indicates that the infields must have been manured to insure their quality (Jacobsen 1987; Krogh 1967).

Fertilization of infields occurred once a year, in early spring when the byres were cleared of the winter accumulation which was then spread on the infield (Albrethsen and Keller 1986). The fertilization of the infields would result in the removal (output) of botanical material from the byre. Albrethsen and Keller (1986) suggest that animals were penned at night to facilitate the collection of manure throughout the year. Fertilization of the fields not only ensured a rich soil for one's hay crop, but also resulted in the reintroduction of seeds from last winter's fodder and bedding. There are no accounts of sowing hay activities as the Norse just cleared and manured the ground and let the vegetation community most suitable overtake the area. It is at this stage in the agricultural system of the Norse that there is a void in our knowledge of Norse technology. Today, fields were hay crops have not been established can be easily recognized by the red colour of the invading *Rumex* sp. (Figure 4).

After manuring the type of maintenance that infield hay crops received is not well known. It is assumed that, other than being supplied with water, they were left alone until ready for harvest. Animals likely caused one of the greater threats to the development of the infield and had to be kept from grazing in the precious infield. Albrethsen and Keller (1986) suggest that the animals were kept out of the infield by using dogs, and maybe fences, although evidence for fences is rare. Brattahilð's infields are demarked by a combination of natural barriers, dykes and fences (Nørlund and Stenerger 1934; Roussell 1936). Albrethsen and Keller (1986) suggested that instead of a

Figure 4. *Rumex acetosella* in modern field near Igaliko (Garðar). Photo by author.

fence being placed around the home field the animals were fenced in pens for the night. This protected the infield, allowed for the collection of manure and a place where animals could be milked in the morning. The other option for prohibiting animals on the infield was to herd them slowly up slope to upland pastures taking advantage of the emerging nutrient rich vegetation.

While people cannot control the natural elements at least they are able to manipulate some of them. Water was one resource that the Norse manipulated. A number of water diversion or irrigation systems have been found during archaeological excavation and survey. Narssaq has a drainage channel within and outside the farm building (Jansen 1972, McGovern and Bigelow 1984). The infield at Garðar is 15 hectares of land in which there is evidence of an irrigation channel coming off a nearby stream (Figure 5). Evidence for irrigation has been found at sites Ø4, Ø36, Ø37, Brattahilð and in Sermilik (Isafjord) (Albrethsen and Keller 1986; Gad 1970; Jones 1986; Krogh 1967). Sandnes in the Western Settlement also has an irrigation system (McGovern *et al.* 1988). Irrigation systems would have made the difference between a good yield and a poor or delayed yield in years when low winter precipitation was followed by a dry summer season (Albrethsen and Keller 1986).

Modern studies done in the Eastern Settlement indicate that during warm and dry summers the precipitation ranges from 110 to 170 mm in the inner and outer fjords, respectively. Cold and wet summers may result in 600 mm of precipitation (Hansen 1991). The balance of soil water throughout a growing period is greatly affected by föhn winds which can cause droughts in dry summers (Hansen 1991). During these periods, vegetation will be more easily damaged by grazing (Jakobsen 1991). Analysis of the 1985 summer,

which was long and warm, showed lower biomass production compared with the summer of 1987, which was warm, but shorter and wetter.
The more continental sites produce more vegetation in the dry summers. But dry summers stress the vegetation in the coastal areas and at higher elevations (Hansen 1991).

Water, as demonstrated by the 1985 and 1987 summer studies, is a critical factor for agricultural success. Irrigation systems used in Greenland and the consequence of their use has not been investigated to its fullest potential. Irrigation systems would modify the infields and the consequence

Figure 5. Irrigation channel at Garðar.
Photo by author.

of their use has been concluded to be positive (Albrethsen and Keller 1986). It is known that irrigation systems also change the water table around the areas being irrigated (Smith 1967) and therefore might have changed the vegetation communities in the outfield. In cores from both Comaium Moes and Galium Kær (Appendix 1) there is evidence of a drop in the water table (Fredskild 1988; 1989) associated with rich growth of dwarf shrubs. Dwarf shrubs are important to the Norse agricultural system (Fredskild 1988). Irrigation systems could have been used to manage the infield providing water and draining the outfield. These irrigation channels also served as a conduit for fresh water plant remains (Bayman *et al.* 1997) to be added (input) onto the infield and from there possibly into a structure.

Based on Icelandic research, an average of 300 kg of hay can be obtained for every productive hectare of infield (Christensen-Bojsen 1991a). There must have been some utilization of off-site pastures even at the largest farms. Garðar's 15 hectare infield would have yielded only 4,500 kg of hay, while the estimated 107 cattle at Garðar would have required between 32,100 kg (Gad 1970) to 470,800 kg (Christensen-Bojsen 1991a) of hay annually. Hay may have been supplemented by feeding cattle dried fish, fish offal and sea weed (Gad 1970) as well as hay from sources away from the farm. The plants that were grown on the infield would surely be a source of fodder which would have been added (input) to the botanical material in the byre.

2.6.4. Outfield

The outfield served the farm in three ways, as a summer pasture to provide summer grazing, as a resource area from which winter fodder could be collected and as the location from which building material was obtained (Arneborg 1991a). Botanical remains from the outfield could be contributed (input) to an archaeobotanical assemblage in the form of manure resulting from outfield grazing and as winter fodder or building material brought back to the site. The extent and particulars about how the outfields in Greenland were used is unknown although a number of suggestions have been made. However, it must be remembered that the agricultural system used will depend on the size of farm and the labour force available, both of which reflect the wealth of the farm. No one pattern will be suitable for all farms.

Most of the discussion dealing with the use of the outfield has related to the use of *sæters*. *Sæters* are used around the North Atlantic as part of a transhumance involving the regular movement of herds from one location to another. A *sæter* may be associated with a range of activities from a full *sæter*, milk *sæter* or hay making *sæter*. Written evidence from Norway and Iceland indicates that *sæters* were used there as early as A.D. 1075 and their use extended right up to the eighteenth century (Albrethsen and Keller 1986). Originally, a full sæter was used during the summer to protect the infields by having animals exploit distant pasture land. Albrethsen and Keller (1986) suggest that in time Icelandic *sæters* were used more and more for the collection of winter fodder.

The use of *sæters* in Greenland is likely, although the evidence for *sæters* or their role in the Greenlandic farming system is not clear. Svend E. Albrethsen and Christian Keller surveyed Tunugdliarfik Fjord (Eiriksfjord) as part of the 1974-1977 Nordic Archaeological Project and discovered a number of ruins at elevations 200-400 m a.s.l, higher than previously known ruin groups (Albrethsen 1991; Albrethsen and Keller 1986). They classified some of these ruins as full, milking or hay making *sæters* (Albrethsen 1991). From a literature review Woollett (1987) suggested that ruins with higher elevations from the Western Settlement might provide archaeological evidence of *sæters* and thus proof of "mountain pasture". The ruins that Woollett suggested include V35 and V36, which are about 250 m.a.s. l., and possibly V4a, V31, V32, V33, V37 and V74. Ruin groups which are assumed to have been fully operating farms may in reality have been used seasonally fulfilling the role of a *sæter* although not placed in traditional upland locations (Christensen-Bojsen 1991b). This may be the case as *sæter* do not have to be situated very far away or above the permanent farm (Albrethsen and Keller 1986) as the key is access to good pasture lands. The debate as to the existence and use of *sæter* in Greenland is hindered by the lack of positive survey results, few surveys at higher elevation, and potential *sæter* structures have not been excavated.

Sæter use is a form of "decentralized farming" (Albrethsen and Keller 1986:101), and they suggest that the poorer the land the more decentralized the farming system will be. The extent to which the *sæter* will be exploited depends on the quality of resources accessible to the farm. Complete *sæter* are assumed to have been established in highly populated areas where there is a need to exploit upland pastures. Milking *sæters* would be used in areas that did not have as high a quality of upland grazing areas, while hay making *sæters* would be found in marginal areas (Albrethsen 1991).

In the *Speculum Regale* there are descriptions of men going high up into the country and climbing the highest mountain to see if there was inhabitable land and not just ice (Jones 1987; Krogh 1967). It seems unlikely that the Norse, given such a busy summer season, would take time to stroll up a mountain. More likely these explorations occurred during the exploitation of the uplands for fodder.

There is general agreement that the Norse would not be able to grow enough winter fodder on their infields for their animals and so while the animals grazed in the outfields fodder must also have been collected from the surrounding areas (Gad 1970). Even at the larger farms such as Brattahilð there are hay yards (stakkgarðr) suggesting distant fodder collection (Nørlund and Stenberger 1934). The process of hay collection off site required the hay be cut, gathered and ricked in the summer and then brought down to the farm (Gad 1970). From other North Atlantic locations it is known that in times of fodder shortage animals were also fed seaweed and fish (Fenton 1978; McGovern *et al.* 1983). This is also practiced by sheep farmers in Greenland today (Jacobsen 1987). Although seaweed has been found in archaeological contexts in Greenland the isotopic ratios from zooarchaeological remains of domestic animals indicate that the use of marine resources may have been insignificant (Buckland *et al.* 1996). The type of fodder provided to the animals would likely depend on not only fodder avaliablity but also on whether the animal was to be used for meat, milk or wool (Christian Keller, University of Oslo, personal communication 1997) the intended use of the animal The fear of a fodder shortage must have plagued the Norse every year and this preoccupation filled their summer days with work.

2.6.5. Wild Animal Resources

Farming, although important ideologically, was not the only resource the Norse depended upon for survival. The zooarchaeological record shows a dependence on wild or hunted foods which were exploited immediately upon settlement (Berglund 1986; Vebæk 1991a). Seal bones tend to be encountered most frequently at Norse farm sites, ranging between 30 and 80 percent of all the animals bones recovered (McGovern 1980, 1992). Frequency differences reflect the status of the farm, with more seal bones recovered from lower status farms (McGovern 1993a). Although there is no evidence of a specialized seal hunting technology (Vebæk 1991), the Norse were successful seal hunters. The utilization of reindeer occurred along with settlement (Berglund 1986; McGovern *et al.* 1996), as evident by bone assemblages and other supporting material. There are a few ruins situated on present day reindeer migration routes although most farms are situated only within a few kilometers of these routes (McGovern 1980, 1992). Norse hunting stations have been found and these include blinds and/or rock fences (Christensen-Bojsen 1991a, 1991b; McGovern and Jordan 1982; McGovern *et al.* 1996). The masonry style indicates that these structures are associated with the Norse and not Inuit (McGovern and Jordan 1982). Both the seal hunt in the spring and the reindeer hunt in the autumn were likely highly communal in character requiring large numbers of men to be successful (McGovern 1991; McGovern *et al.* 1996)

In addition to the wild animals that were exploited for food, animals were also hunted for trade and raw material. The Norðrsetur region, which consists of the modern day Aasiaat (Egedesminde) up to Disko Bay and the Nugssuaq Peninsula (Krogh 1967), is about 800 km from Godthåb (Nuuk) and the Western Settlement (McGovern 1985; McGovern *et al.* 1996). Use of the Norðrsetur enabled the Norse to hunt or trap seals, walrus, narwhal, polar bears, reindeer, Arctic foxes, and white Greenland falcon. The seal and reindeer were hunted for subsistence but the falcon, foxes, polar bears, walrus and narwhal were hunted for the market economy (McGovern 1985). Norðrsetur products were used to pay taxes to both crown and church, and to attract trade with Icelandic and Norwegian merchants (Krogh 1967). The hunting that occurred in the Norðrsetur must have been extensive because the tithes received from Greenland were substantial. For example, in A.D. 1327 the tithes amounted to 127 stones of walrus ivory (653 kg) which is the equivalent to 373 tusks or 189 walruses (Gad 1970). Gad (1970) suggests that this must represent the harvest over a 6 year period (31 walrus per year). Hunting techniques suggested by McGovern (1985) have the potential of killing hundreds to a thousand walrus at a time. The only restriction on the number of animals killed would be the amount of cargo that could be safely transported home in the six-oar boats. Due to the seasonal location of the animals and sailing conditions, use of the Norðrsetur was restricted to the summer months when the long trip must have overlapped with the peak of activities on the farms. In all, trips to the Norðrsetur were costly in terms of resources for boats and weapons, and men's lives and labour (McGovern 1993a).

A hypothetical schedule (Figure 6) of farm and hunting activities indicates that the spring, summer and early autumn would have been extremely busy times with most of the important farming and hunting activity occurring then (McGovern 1993a). This raises a key issue as to how labour was organized.

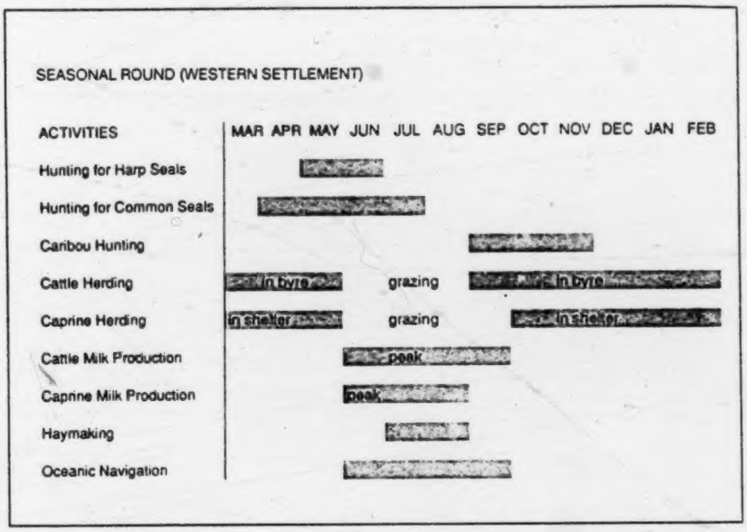


Figure 6. Hypothetical Norse seasonal round (Western Settlement). Reprinted by permission, McGovern 1993a, *Historical Ecology*.

2.6.6 Division of Subsistence Activities

The above review of settlement and agricultural practices in Greenland is generalized and based on information drawn from research in the Eastern and Western Settlements. It should not be forgotten that the two settlement areas differed in climate and specific subsistence activities (McGovern 1987, 1991).

The Western Settlement was in a more precarious situation in terms of agriculture successes due to more limited pasture land and a slightly cooler climate (McGovern 1987). Compared to the Eastern Settlement, the Western

Settlement had more barn space for hay in relationship to space for cattle in byres (McGovern *et al.* 1995), an indication that the Western Settlement needed more winter fodder for its longer winter (McGovern *et al.* 1995). The numbers and types of domestic animals that could be sustained in the Western Settlement differed. Zooarchaeological evidence indicates that there was a higher goat: sheep ratio in the Western Settlement and fewer cows than in the Eastern Settlement (McGovern 1987).

In Iceland, a farm's status was based on the type and quantity of domestic animals supported; a similar system of assigning status is likely for Greenland. Farms that were able to support more cattle were considered to be of a higher status (Christensen-Bojsen 1991a, 1991b) and presumably those with a predominance of goats were the lowest status farms. If a similar system of status determination was used in Greenland, the Western Settlement would possibly have had a lower status than the Eastern Settlement. But the Western Settlement's proximity to the Norðrsetur might have influenced its status. The Western Settlement had easier access to the crucial status goods used to pay taxes for all of Greenland. Access to exotic goods likely factored into the status attributed to the Western Settlement as a whole and to individual farms. The role the Norðrsetur played in terms of the economic relationship between the settlements is however conjectural.

The Inuit/Nordbo Project has developed a topographic economic model that divides the Western Settlement into three farm types based on resource exploitation (Berglund 1986). The first farm type includes well situated interior farms which had access to large quantities of high quality pasture lands; the second includes inland farms that would have been specialized in hunting reindeer while maintaining small numbers of domestic animals; and the third includes coastal farms which were situated to exploit marine resources while still maintaining domestic animals (Berglund 1986). Locally available resources would then be traded between the three farm types. Zooarchaological evidence provides proof of this trade network as the bones of wild animals (both marine and terrestrial) occur in frequencies inversely proportional to their frequencies in local niches. Seal bones are abundant at small inland farms while reindeer bones are frequent at the coast (McGovern 1992). There was presumably a well coordinated use of communal labour from all farms to exploit the wild resources to the fullest potential at the correct time (McGovern 1993a).

In light of new paleodemographic models (Lynnerup 1996), Greenland likely had a chronic shortage of labour. The small labour force combined with the fact that the majority of the subsistence activities had to be done concurrently (Figure 6) may have resulted in an additional division of farm activities than those indicated by the topographic economic modle. The second and third farm types (Berglund 1986) could be divided internally based on gender (Figure 7). Due to a labour shortage, the role of women in all areas of economic activity must have been considerable. Krogh (1967) places Norse Greenlandic women indoors making cheese and butter, drying and salting meats, cooking and sitting at the loom making homespun. In other parts of Scandinavia women were responsible for a wider range of farm responsibilities (Hastrup 1989). The responsibility for hunting, fishing, farming and church building, much of which would occur at the same time, is that of men (Krogh 1967).

At the height of the Norse Settlement of Greenland the population may have been 2,250 (Lynnerup 1996). The male:female ratio from Thjodhild's churchyard is based on 144 skeletons, 39 adult females and 65 of adult males (Krogh 1967). Assuming that this ratio can be projected on to the Norse

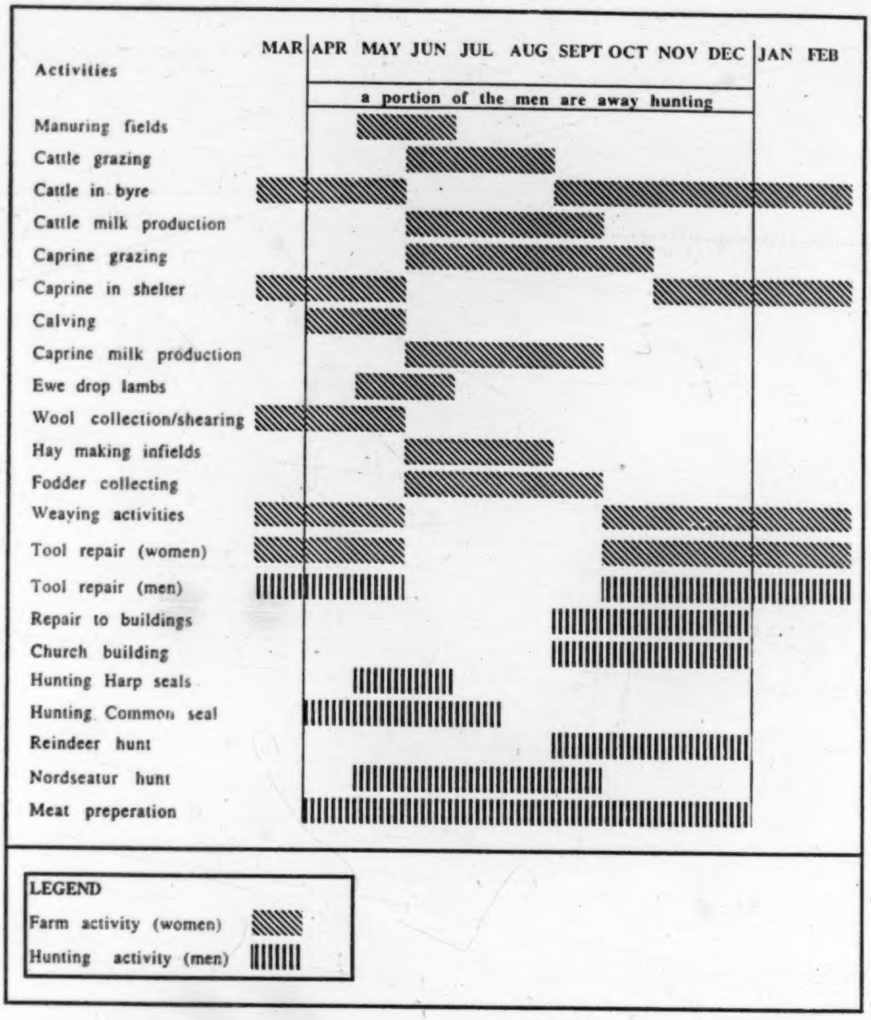


Figure 7. Hypothetical division of labour based on gender for Greenlandic Norse farm (Western Settlement). After McGovern 1993a.

Greenlandic population at the height of settlement there might have been an estimated 609 females and 1,015 males, most of whom lived in the Eastern Settlement. It is unusual that males are favored but this ratio is also found in the 20th century Upernavik district sex ratios (Mary Jackes, University of Alberta, personal communication, 1997; Jørgensen et al. 1978). In the

Western Settlement there were at most 90 farms and in the Eastern Settlement 190 to 220 farms (Gad 1970; Jones 1986, 1987; Krogh 1967; Vebæk 1991b). Based on the number of farms, the Western Settlement is less than half the size of the Eastern Settlement so an estimated population for the Western Settlement of 300 females and 500 males is reasonable, if a little high. This places about 3 females and 5 males on each farm. These five males, assuming they were all physically capable, were responsible for participating in hunting for Common seal from March to July, Harp seal from April to June, Norðrsetur activity from June to September and reindeer hunting from September to December (McGovern 1993a), and according to Krogh (1967) farming June to September.

The amount of work that was needed to be completed in the summer and the shortage of labour may have resulted in the two main economies, hunting and farming, being divided predominately along status and gender lines. Scandinavian society was arranged along hierarchical lines with three basic categories, chief, freemen and serf (Jones 1987); Norse Greenlandic society presumably followed these same divisions to some extent. To what degree this social stratification influenced the division of subsistence activities is uncertain but it seems reasonable to suggest that subsistence activity deemed hard, culturally difficult or of an unpleasant nature would have been delegated to those of the lower social strata (Whiteford and Friedl 1992). Krogh (1967) suggests the subsistence activities he thought were appropriate for two genders, men and women (Ward 1996). I would suggest a slight variation in his assignment of subsistence activities. The hunting schedule would be a 'man's activity' and the farming schedule would be predominately a 'woman's activity' (Figure 7). These activities are not to be thought of as being divided along biological sexes but on the culturally assumed appropriate roles of the genders (Ward 1996; Whiteford and Friedl 1992). Those involved in hunting activity presumably included all the able bodied biological males, including or excluding males from any social strata depending on what was culturally acceptable. Biological females, children (both biological female and male) and any biological males that where not physically capable to hunt would be responsible for the farm activities. This activity could also include or exclude males from any of the social strata, depending on what was culturally acceptable. This is not to say that able bodied biological males were excluded from farm activities as they were presumably a crucial and integral part, but women may have been more active in this subsistence activity than Krogh (1967) suggests.

The archaeological record should be re-investigated in order to determine if a gender based dual economy can be demonstrated more generally in the Norse cultural system. Evidence from Viking age burials in Norway indicate that women, from areas where men tended to be away trading, had burials which contained a greater number of high status indicators. This is unlike burials in regions where it was surmised that the men were at home on the farms (Dommasnes 1982). The conclusion is that when women were in charge of the farm, due to the men's preoccupation with other economic demands, they had a higher status than women who were not totally responsible for the daily activities of a farm. The material culture should be carefully examined in order to determine if artifacts associated with farming can be identified as belonging to women and if there where such gender differences between the Eastern and Western Settlement. The spade in Figure 8 was suggested by Guðmunder Ólafsson of the Icelandic National Museum to belong to a woman because of the woman's marker engraved on it. Unfortunately, the introduction of Christianity may have eliminated evidence based on burial practices (Vebæk 1991b). For now the only difference in burial practices is that the men were buried on the sunny, south side of the church and the women were buried on the cold, north side of the church (Krogh 1967). This difference in burial practices is based solely on sex and not on other economic factors. Status differences over the whole population needs to be established and compared so that high ranking women are also compared to low ranking males.

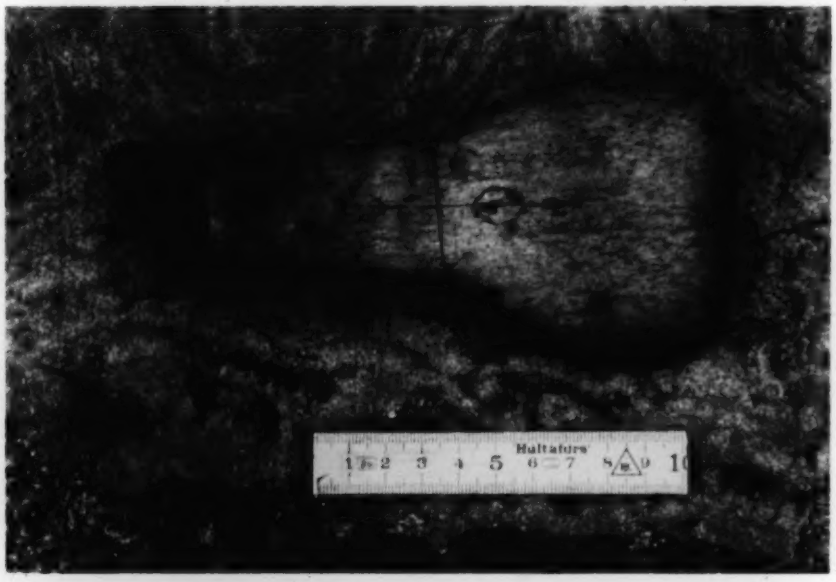


Figure 8. Spade with a possible woman's marker GUS.
Photo by Sven Erik Albrethsen.

2.7.0. Abandonment

The history of Norse Greenland ends with the abandonment of the settlements. Abandonment of the Western Settlement is believed to have occurred ca. A.D. 1350 and may have affected the Eastern Settlement more than is often assumed, which was abandoned ca. A.D. 1500 (Gad 1970. After all it is likely that these settlements were interconnected to some degree politically and economically. There are many hypotheses for the Norse disappearance from Greenland. Some of the hypotheses include: congenital or intermittently hostile interaction with the Thule Inuit, pirate attacks, general decrease in the well-being of the population, caterpillar infestations, climatic change, non-sustainable adaptations, trade isolation and gradual emigration back to other regions around the North Atlantic. The final explanation for the Norse desertion of Greenland will likely be a combination of some or all the proposed hypotheses (Gad 1970; McGovern 1981, 1991).

Hypotheses which would modify vegetation and therefore archaeobotanical assemblages include: caterpillar infestations, climate change and non-sustainable land use practices. The other hypotheses will not be discussed here although they have all been dealt with in great detail in the following sources: Thule-Inuit and Norse Interactions (Arneborg 1993; Bruun 1918; Gad 1970; Gullvø 1983; Ingstad 1969; Jones 1986, 1987; Keller 1991; Knuth n.d.; Magnusson and Pálsson 1965; McGhee 1987; McGhee and Einarsson 1983; Meldgaard 1976; Nørlund 1936; Schledermann 1979, 1980; Scott and Halffman 1991); the significance of pirates (Jones 1986; Knuth n.d.; Krogh 1967; McGhee 1987); evidences for disease and/or inbreeding (Gad 1970; Jones 1986, 1987; Krogh 1967; Lynnerup 1991; Lynnerup *et al.* 1990; Magnusson and Pálsson 1965; Nørlund 1936; Scott and Halffman 1991); trade isolation (Gad

1970; Jones 1986, 1987; Keller 1991) and emigration (Berglund 1986; Jones 1986; Keller 1991; Krogh 1976; Lynnerup 1996).

2.7.1. Caterpillar Infestation.

Historical reports and archaeological finds suggest that some of the Western Settlement pastures were greatly reduced by a caterpillar that today and presumably in the past infested the landscape, eating the spring vegetation growth (Berglund 1986; Jones 1986; Nørlund 1936). This theory was first put forward by Johannes Iversen who identified the caterpillar as *Agrotis occulta* (Fredskild 1989). In the Sandnes midden large numbers of this caterpillar stratigraphically followed a layer containing grass pollen, assumed to be from the Norse infield (Gad 1970). The caterpillars are credited with having stripped the entire area of vegetation (Gad 1970), which would certainly have had catastrophic consequences on the condition of a flock or herd emerging from the byres and weakened by a long winter. They faced competition with this caterpillar for the newly developing nutrient rich vegetation in the area (Berglund 1986). From personal experience the vegetation cover around GUS in 1995 was lush (Figure 9), however in the following year most of the vegetation was stripped of leaves which had been eaten by the caterpillars (Figure 10) that were seen everywhere scattered on the ground. The caterpillar alone could have resulted in a family losing a significant amount of livestock, but it is unlikely to have caused the abandonment of Greenland (Berglund 1986).

Figure 9. 1995 Lush vegetation in valley behind GUS site.
Photo by author.

Figure 10. 1996 Vegetation in valley behind GUS site following caterpillar attack.
Photo by author.

2.7.2. Climate

Evidence supporting climate change comes in many forms: historical documents, archaeological data, ice core data, botanical evidence, and other proxy data. Not all of this data is in accordance. Most of the Viking expansion took place during what scientist refer to as the climatic optimum of the Medieval Warm Period dated ca. A.D. 800 to 1200 (Jones 1986; McGovern 1991); a general term for warm periods that reached there optimum at different times across the North Atlantic (Groves and Switsur 1994). During this time the mean annual temperature for southern Greenland was 1 to 4°C higher than today. Without this amelioration in climate, it would have been impossible for some of the North Atlantic voyages to have taken place including Eirik the Red's Greenland discovery voyage (Jones 1986). Over the years, data has accumulated to demonstrate that the climatic situation of the North Atlantic changed and deterioration progressed for the next two hundred years when around A.D. 1430, Europe enters what is referred to as the Little Ice Age (Jones 1986). The Little Ice Age may have contributed to a number, or possibly all, of the farms of the Western Settlement being abandoned but it does not explain the abandonment phenomena of Greenland as a whole. The Eastern Settlement survived two cold periods indicated by ice core data and was actually abandoned during a period of climate amelioration.

Historical documents mention the increased hardships due to changes in sailing routes. For example, the *Speculum Regale* testifies to an increase in ice flows from the Polar Sea carried southward by the east Greenland current to Cape Farvel. This ice is then carried north to the Eastern and Western Settlements. Ivar Bardarson, famous for his description of the abandoned Western Settlement, also indicates that the shortest sailing route to Greenland from Iceland was straight west departing from Snæfellsnes where in two days and two nights one would reach Gunnbjarsker Island. Gunnbjarsker was a half way point from which one could sail to the Eastern Settlement. This direct route west had to be abandoned around A.D. 1360 due to the polar ice coming down from the northeast. Departing from Snæfellsnes one could now only sail one day and one night westward before having to change course to a southwest direction or be lost in the ice (Jones 1986). Accounts of ice reaching further and further around the south tip of Greenland and up the west coast are indicative of this cooling trend.

The archaeological evidence of climate change is found in garments excavated from Herjolfsnes in the early 1900's. Their excellent preservation is used as an indication that the climate became colder shortly after the time of burial and was colder than today. It is thought that when the bodies were buried, the ground around them froze permanently until they were excavated five hundred years later (Nørlund 1936). A number of the remains in the grave yards are poorly preserved but a few graves dated to the fifteenth century (based on clothing style) are in an excellent state of preservation(Nørlund 1936).

Data from the Greenland ice cores provides a paleoclimatic record of annual resolution. It is known from oxygen isotope analysis that the climate at the beginning of the Norse period was similar to that of today but slightly warmer. There was a general decrease in temperature until the time of the abandonment of the Western Settlement the temperature had reached its lowest value since settlement (Hansen 1991). Studies based on deuterium from GISP2 suggest considerably lower temperatures in A.D. 1308-1318, 1324-29, 1343-62 and 1380-84 (McGovern *et al.*1 995). Temperatures had already recovered when the Eastern Settlement was abandoned (Hansen 1991). It is not until A.D. 1560 that another cold period occurs (McGovern *et al.* 1995). Recorded in the Greenland ice core data are also a number of volcanic eruptions which occurred in A.D. 1105, 1179-80, 1229-1230 and 1258-1260 (Hansen 1991). The volcanic activity might have altered the amount of solar radiation reaching the vegetation, thus reducing the quality and quantity of fodder (Fredskild 1989).

Botanical evidence for environmental change during the Norse period is not as easy to secure. The agricultural activity of the Norse left a signature in the vegetation record making it difficult to separate those changes that are the result of climatic change on the natural vegetation over short time periods (O'Brien *et al.* 1995). Paleoenvirnmental studies generally can document changes over centuries but not changes within decades (McGovern 1991). Pollen and macro investigations undertaken near Norse farmsteads in the Eastern and Western Settlement consistently indicate fluctuations between dry-moist-dry-moist conditions (Fredskild 1989) over approximately 600 years. *Landnám* occurred during the first dry period; the Norse continued their farming practices through a moist and subsequent dry period. It is within the time span of the second moist period that the Norse abandoned Greenland (Fredskild 1978), although Iversen's work suggests that a drought occurred just prior to the disappearance of the Norse from the Western settlement (Nørlund 1936). The flowering of *Myriophyllum alternifiorum* (Water-milfoil) also indicates changes in climatic, and not anthropogenic influences during the Norse times. Evidence from two lakes suggests that *Myriophyllum alternifiorum* stopped flowering in Western Greenland long before the Norse arrived. At approximately the time of settlement and for a few centuries after settlement, *Myriophyllum alternifiorum* flowered. This may indicate an improved summer conditions for part of the Norse occupation of the Western Settlement (Fredskild 1989). The flowering of *Myriophyllum alternifiorum* might also related to the amount of solar radiation reaching the vegetation therefore overcast summer due to storms or volcanic ash may result in *Myriophyllum alternifiorum* not flowering . Although it is unlikely that climate change was the only reason for the abandonment of Greenland, we know that a colder climate would have affected the ability of the Norse to continue their regular pattern of subsistence and trade.

2.7.3. Non-Sustainable Land-Use Practices

Non-sustainable land-use practice have been advanced as a cause for demise of the Norse settlements although there are clearly arguments against this explanation. A number of Norse site (Sandnes, GUS, 64c) have aeolian or fluvial sand deposits either covering them or associated with them. These deposits may have been the result of climatic changes, tectonic activity or sediment release due to poor land use practices of the Norse (McGovern *et al.* 1996). The reintroduction of sheep farming during this century has resulted in an increase in erosion (Fredskild 1988). A similar increase in erosion is evident by a concentration of magnetic minerasl from cores taken from near Garðar (South Igaliko) and Brattahilð (Qagssiarssuk) during the Norse period (Sandgren and Fredskild 1991). Once sheep expose the fine particles of the A-horizon and the protective vegetation cover is gone due to grazing, wind and rain erode the soils (Jakobsen 1991). Jakobsen (1991) found evidence of past erosion in type 3 and 4 soil profiles; both profiles exhibited sediment which contained charcoal fragments representing Norse clearing activities buried beneath aeolian material. The idea that grazing, wood cutting and peat cutting result in mass erosion leading to the disappearance of the grass land so crucial to Norse existence is supported by Gad (1970), Jacobsen (1987), Jakobsen (1991), Fredskild (1988, 1989, 1992).

A different view is presented by Rutherford (1995) who examined the soils of six southern Greenland locations and concluded that the soils found in Greenland are "typical of well developed soils in areas free from ice for at least 9000 years at the same latitude" (Rutherford 1995:327). None showed evidence of buried A or Bf horizons and all had soil chemistry consistent with a monoperiodic soil adequate for Norse agriculture. Rutherford (1995) concluded that widespread soil erosion had not taken place. The soils that Rutherford (1995) investigated might be equivalent to Jakobsen's (1991) type 1 soil which is "not noticeably affected by soil erosion/depositions features, is rather uncommon in the area. It has a very distinct podzol morphology developed in till/glaciofluvial material covered by late glacial loess" (Jakobsen 1991: 60). It seems as if different conclusions were reached because different soils were examined. For now nothing definitive can be said as to whether the Norse implemented non-sustainable land use practices.

The abandonment of Greenland was likely the result of a combination of the eight proposed causes. But ultimately most of these causes could have been mediated, except possibly attack by pirates, if survival in Greenland was the objective. The Norse had a number of options that would have provided a more secure existence than what provided by farming. The Norse could have, (1) adopted coastal settlement and abandoned or significantly reduced inland herding practices, (2) adopted Thule-Inuit hunting technology, including specialized weaponry such as harpoons with floats and skin boats, and (3) abandoned the time consuming effort of church building. Any of these options might have been enough for the Norse to survive another hundred years (McGovern 1981, 1991). Archaeologically there is evidence that the *landnám* settlers had been ingenious and adaptive upon their first arrival. For example, the change of housing style from long house to centralized farmsteads was for greater heat efficiency (Gad 1970). Over time, one might expect more ingenuity, but the Norse seemed to lose their ingenuity, not even adopting one of the many superior technologies of the Thule-Inuit (Vebæk 1991a).

Explanations for the disappearance of the Norse have been largely attributed to external forces operating on the culture but there may have been internal forces working against the Norse as well. Changing subsistence practices might have been stigmatized; to do so would mean becoming a *skræling* or heathen and this was something the societies' leader, be they churchmen or chieftain (Arneborg 1991b; Keller 1991; McGovern 1981, 1990, 1991), could not allow. While changing subsistence practices might have ensured survival of the body, it surely jeopardized the Christian soul. The Norse may have been so culturally bound to their fields and farms that they were unable to realize the usefulness of subsistence options available to them (McGovern and Jordan 1982) which would have allowed for the mediation of most of the proposed causes of abandonment.

The Norse could only operate within the bounds of their cultural frame- work even when confronted with significant challenges such as climate change or Thule-Inuit expansion. Whether their choices were a stubborn and deadly commitment to the inland farms and churches or a dislike for the Inuit way of life, the Norse society, be it the upper echelons or the lower ranks, chose not to survive in Greenland.

CHAPTER 3 SITE DESCRIPTION

3.1.0 Geographic Location

Greenland (Kalaallit Nunaata), located between the Atlantic and Arctic Oceans, is the largest island in the world. The surface area of Greenland is 83 % covered by an ice cap of 1,833,900 km^2. There are 341,700 km^2 which are ice free and nowhere is this ice free area wider than 200 km (Bard 1954; Kampp 1978; Schou and Antonsen 1960). The ice free areas include a complex of fjord systems which create micro climates within Greenland. As would be expected the climate will differ depending on one's southerly or northerly location; less expected but more extreme is the east-west variation in climate. Climate differences between the continental inner and coastal outer fjords can be significant.

Most of the Norse farms found in the Western Settlement are situated between 64°N and 65°N in Godthåbsfjord (Nuuk Kangerluaq), Ameralik Fjord and connecting valleys (Jansen 1972). Mean summer temperature at interior sites is 9.7°C with the warmest mean July temperature of 10.9°C recorded at the head of Godthåbfjord (Fredskild 1989). The Western Settlement is as warm as the Eastern Settlement but has only a five month growing season whereas the Eastern Settlement enjoys seven months. Farm sites near the inland ice can be greatly affected by föhn winds which can blow warm dry air at speeds of 32 to 48 km/hr (20 to 30 m/s) (Sandgren and Fredskild 1991).

Typically, Norse farmsteads in the whole of the North Atlantic are placed on prominent locations with a large mountain towering behind

(Jansen 1972). Gården Under Sandet (64°06'N, 50°05'W, 130 m a.s.l.) is in just such a place. GUS is situated on the north side of the valley at the end of Ameralla fjord between Naajat Kuuat and Isortuarssuk Lake (Figure 11 and 12). Behind the farm are the mountains of the valley side that range from 700 to 900 m a.s.l. and in front of the farm is the broad flood plain of a braided river (Andreasen and Arneborg 1992, Arneborg and Berglund 1994). The site is about 10 km or slightly over 5 km as the crow flies, downstream from the outlet glacier, Kangaussarssûp. The braided river fed by Kangaussarssûp has formed an active, sparsely vegetated, gravel flood plain over 5 km wide. Air photographs over the last thirty years show that the river channels have been slowly moving northward (Andreasen and Arneborg 1992). On the south side of the flood plain a river enters fed by Isortuarssuk Lake which is dammed for electrical power. Unlike the braided river which is milky with rock flour this second river is clear and contains fish. The advance of Kangaussarssûp probably during the Little Ice Age resulted in aggrading of the flood plain and burial of GUS. Retreat of Kangaussarssûp during recent warmer decades has resulted in degradation of the flood plain and exposure of GUS (Schweger in press).

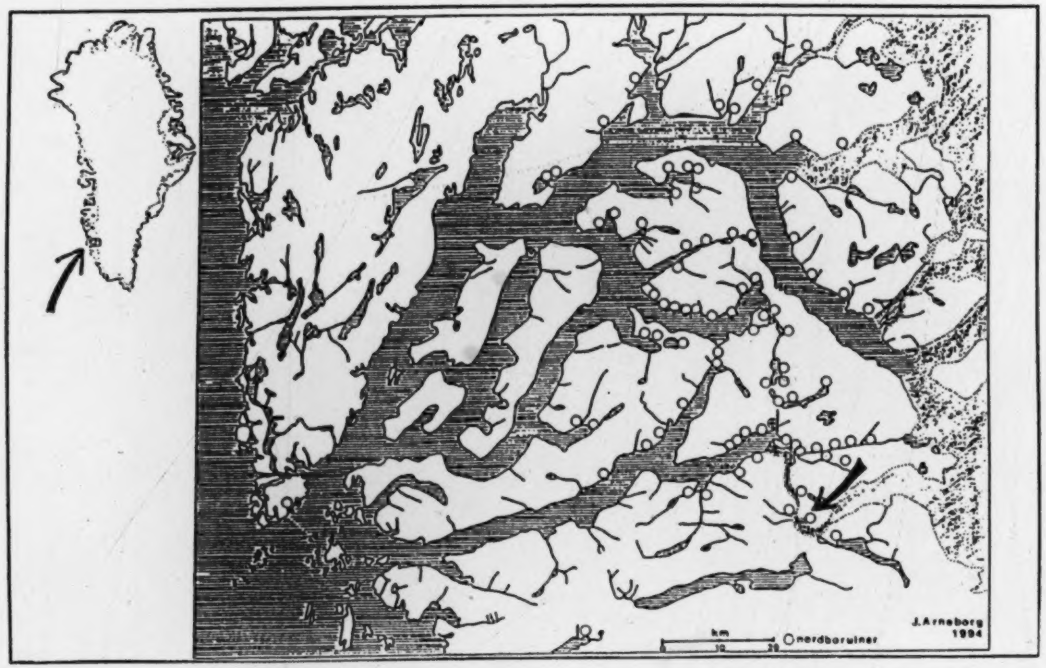

km
0
10
20
○ nordboruiner
J. Arneborg
1994

Figure 12. Western Settlement. Farms indicated by circles the arrow points to GUS.
Reprinted by permission, from Arneborg and Berglund (1994) The Greenlandic National Museum and Archives

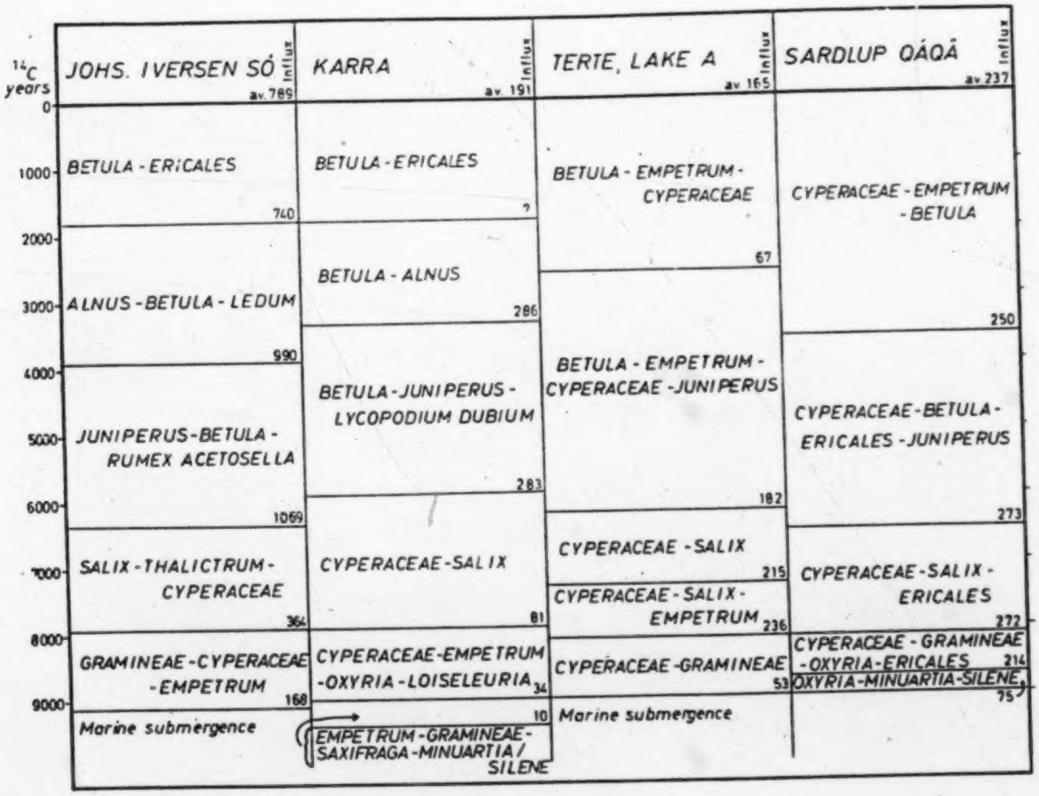
Figure 12. The GUS site is located at the middle of the photograph adjacent to the river and opposite the prominent point bar. White tents on terrace make up the camp.
Photo by author

3.2.0. Vegetation History of Western Greenland

The following vegetation history is a summary of the extensive and detailed work of Bent Fredskild and Johannes Iversen. For a complete vegetation history and understanding of the subtle vegetation changes of

Greenland please see Fredskild (1967, 1973, 1978, 1983a, 1983b,1985, 1989, 1991, 1992).

The first stage in the vegetation history follows deglaciation which occurred about 9000 B.P. This Pioneer Stage (9400 - 8000 BP) sees plants which had survived the period of glaciation on nunataks (high mountain peaks which remained ice free) and other unglaciated areas expand onto the fresh, unstable, minerogenous soils exposed through ice retreat (Table 1). Based on



14C years
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
JOHS. IVERSEN SÖ
Influx
av. 789
BETULA - ERICALES
740
ALNUS - BETULA - LEDUM
990
JUNIPERUS - BETULA - RUMEX ACETOSELLA
1069
SALIX - THALICTRUM - CYPERACEAE
364
GRAMINEAE - CYPERACEAE - EMPETRUM
168
Marine submergence
KARRA
Influx
av. 191
BETULA - ERICALES
?
BETULA - ALNUS
286
BETULA - JUNIPERUS - LYCOPODIUM DUBIUM
283
CYPERACEAE - SALIX
81
CYPERACEAE - EMPETRUM - OXYRIA - LOISELEURIA
34
10
EMPETRUM - GRAMINEAE - SAXIFRAGA - MINUARTIA / SILENE
TERTE, LAKE A
Influx
av. 165
BETULA - EMPETRUM - CYPERACEAE
67
BETULA - EMPETRUM - CYPERACEAE - JUNIPERUS
182
CYPERACEAE - SALIX
215
CYPERACEAE - SALIX - EMPETRUM
236
CYPERACEAE - GRAMINEAE
53
Marine submergence
SARDLUP QÂQÂ
Influx
av. 237
CYPERACEAE - EMPETRUM - BETULA
250
CYPERACEAE - BETULA - ERICALES - JUNIPERUS
273
CYPERACEAE - SALIX - ERICALES
272
CYPERACEAE - GRAMINEAE - OXYRIA - ERICALES
214
OXYRIA - MINUARTIA - SILENE
75

Table 1. Palaeovegetation Zones of the Godthåbsfjord.
Reprinted by permission, from Fredskild 1983 Figure 10 Danish Polar Center.

fossil occurrences of *Galium brandegei*, *Menyanthes*, *Subularia*, *Limosella* and *Myriophyllum spicatum* it is suggested that the climate at this time was similar to that of today, a few degrees further north. There would have been the same contrast between coastal and interior climate now characteristic of Greenland.

The *Salix*-Cyperaceae Stage (8,000-6,300 BP) documents the dispersal of *Salix* this probably does not reflect climate change. Toward the end of this stage a decrease in Ericaceae/*Empetrum* and presence of open-soil pioneer plants indicates decreased snow cover which changes the heath, and probably caused unstable soil conditions. *Lepidurus arcticus* becames extinct from the lakes and *Alnus* increased. Both changes reflect an increase in temperature.

During the *Betula nana*-*Juniperus* Stage (ca 6,300 -3,500 B.P.),*Juniperus* and *Rumex acetosella* were at their greatest frequencies and west Greenland's climate is considered to have been at its warmest and driest.

After 3,500 B.P., lake cores differentiate into separate vegetation histories: one for the interior (*Alnus crispa*-*Betula nana* Stage) and one for the outer coast (*Empetrum*-Cyperaceae-*Betula nana* Stage). In the interior about half of a millennium passes before a decrease in *Juniperus* and *Rumex acetosella* is seen as well as an increase in *Ledum*. *Alnus* immigrated into the interior at about the same time. These three changes in the vegetation record indicate increasd humidity with continued warm conditions in the interior. Evidence suggests that neo-glaciation resumed at some point between 3,500-3,000 B.P.; there is also evidence for a more severe climate around 2,000 B.P.

The vegetation history of western Greenland shows the greatest differentiation between coast and the interior from 1,800 to 0 B.P. On the coast the *Empetrum*-Cyperaceae-*Betula nana* Stage (1,800-0 B.P) continues from the previous stage (ca. 3,500-1,800 B.P.) with a decline in *Betula* and an increase in Cyperaceae and Ericales all reflecting increased humidity (Fredskild 1973, 1985). In the interior, the *Betula nana*-Ericales Stage sees decreased *Alnus*, and increased *Betula nana* and Ericlaes suggestive of a cooler and more humid climate.

It is during this last stage that the Norse settled Greenland and from the time of their arrival until their departure 300 to 500 years later, the Norse drastically affected the vegetation surrounding them. Not until the abandonment did the delicate sub-Arctic environment begin to reestablish its natural balance.

It is useful to compare and contrast how the Western and Eastern Settlements were altered by the Norse. At some, but not all, Norse farms, the first indication of *landnám* is an increase in charcoal content found in both cores and excavated transects across archaeological sites. It is assumed that this records clearing of the land by fire. At Brattahilð, clearing appears to have been done by axe because there is more evidence of wood chips than fire. The vegetation cleared away was a combination of Ericales shrubs and *Betula nana*.

Weeds, both indigenous and introduced, associated with Norse agriculture were able to establish themselves immediately on this newly prepared ground. An increase in *Montia fontana*, and the introduction of *Stellaria media* and *Capsellabursa-pastoris* occured. In the Eastern Settlement, *Rumex acetosella* was also introduced by the Norse and flourished; *R.acetosella* occurred naturally in the Western Settlement region since 6,000 B.P. and does not seem to have been increased by Norse activity but waits until after the Norse depart from the region to increase (Fredskild and Humle 1991; Fredskild 1973, 1981). *Poa annua*, *Polygonum aviculare*, and *Achillea millefolium* were also introduced (Fredskild 1978). As with the weeds during Norse settlment, Gramineae and Cyperaceae are seen to increase in abundance as other plants such as *Juniperus, Salix, Betula, Artemisia* and *Sedum* declined (Fredskild 1967, 1992).

Shortly before the Norse disappearance from the Western Settlement (Fredskild 1973), the climate became drier and more continental. Cultural layers from both Ujaragssuit and Umîviarssuk contain *Montia fontana* and *Ranunculus hyperboreus*; above these cultural layers there is evidence for a drier climate. At Ujaragssuit the dry period is seen in peat growth containing *Polygonum viviparum* and *Calamagrostis langsdorfii* and at Umîviarssuk there is a layer of a bright brown moss. These two sites suggest a moist (cultural) period was followed by a drier period (Fredskild 1973). Once the Norse abandon their farms there is an immediate drop in perennial and annual weeds and *Salix* increases probably as a response to lack of grazing (Fredskild 1978).

3.3.0 Vegetation Communities at GUS

The anthropogenic impact that the Norse had on the vegetation of the GUS area has been erased by time and the river. During the 1995 field season the vegetation of the GUS area was described qualitatively by identifying seven geobotanical units. Plant references material was collected from these units. Starting with the vegetation directly around the site and moving outward and upward in elevation the plant communities are as follows: 1) The river flood plain which is sparsely vegetated with plants typical of fell field or communities on solifluction soils. Some of the plants include *Silene* *acaulis, Polygonom viviparum,* Gramineae and *Draba* sp., 2) Dry southwest facing slopes, which are essentially covered by *Salix* sp. and Gramineae . (Figure 13), 3) Moist northeast facing slopes covered mostly by *Betula nana, Ledum* sp., *Rhododendron* sp. and *Vaccinium* sp.(Figure 13), 4) Mountain slopes covered with a herb dominated meadow like vegetation (Figure 14), 5) Highland meadow found behind the first rise of mountains beyond the site (Figure 15), 6) Pond areas many of which in the summer of 1995 were dry and in 1996 were wet. Some of the plant communities included in this group are *Hippuris vulgaris, Juncus* sp., *Carex* sp., *Eriophorum* and other fresh water plants, and 7) sparsely vegetated sand dunes that were found more distant from the site (Figures 16).

Figure 13. North and south facing slopes near GUS. Photo by author.

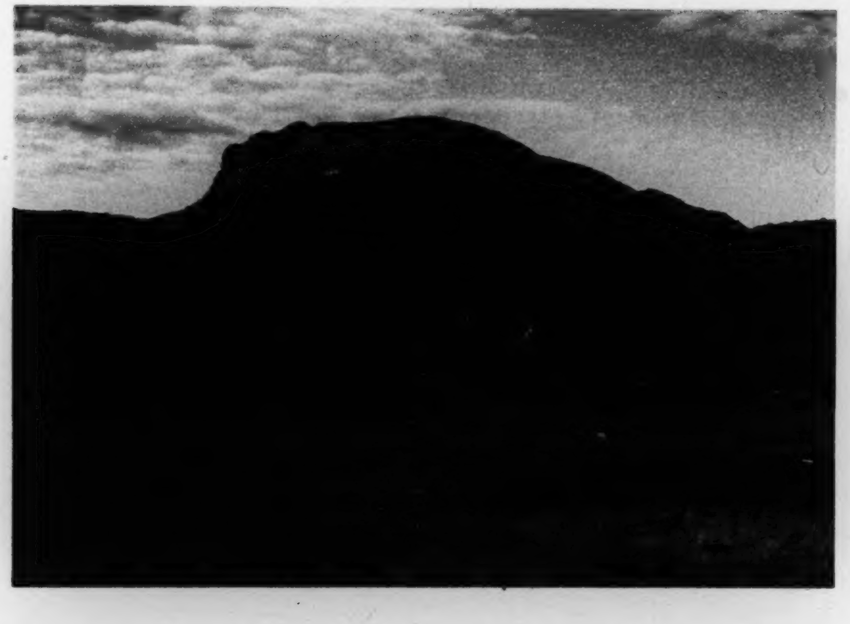


Figure 14. Mountain slope behind camp
Photo by author

Figure 15. Highland meadow areas near GUS.
Photo by author.

Figure 16. Sparsely vegetated sandy areas.
Photo by author.

3.4.0. Archaeology Data from GUS

Gården Under Sandet cannot be considered just another Norse farm in Greenland. Most of the farms excavated in Greenland were only excavated to expose the last occupied, or abandoned living floors (Krogh 1967). Because the GUS site was being destroyed by river erosion, it was excavated to the first structure, the first completely excavated Greenlandic long house. GUS is a centralized farm and the six years of excavation have revealed about 27 rooms and six construction phases. The farm structure is at least, as part may have been lost through erosion, 40 m long and 12-15 meters wide (Andreasen and Arneborg 1992), roughly the same size as Austmannadalen (nr. 519) also from the Western Settlement, excavated in 1937 by Aage Roussell. Following its abandonment GUS was buried by 1-2 metres of alluvial sand and sealed by permafrost. These specific conditions have resulted in extraordinary preservation conditions for ecofacts, artifacts and features.

The building techniques used at GUS have not yet been finalized but they are most likely similar to those found elsewhere in Greenland. The Icelandic turf-wall farm building tradition was carried to Greenland by the first settlers who constructed buildings out of turf, stone and timber. Turf was cut from the surrounding area in one of two fashions; *strengur* style in which a thin turf block (1 m by 0.20 m wide and 0.05m thick) was cut and removed with its root mass and the *hnaus* style which results in a much thicker layer of turf being cut. These two types of turf blocks are combined in thin horizontal layers that alternate with diagonally laid thick turf blocks. This process is called *kölmbruhnaus* (Jansen 1972, Roussell 1941). Available stones would also be used by the Norse for construction. Timber, though not easily acquired, was used for roofs, doors, bed and many other wooden artifacts. It is surprising that wood is not more scarce as the source appears to have been predominately drift wood brought from Siberia on the Polar Stream or the result of voyages to North America (Jansen 1972). The traditional Icelandic construction style changed to the passage-house which later (late A.D. 1200's) developed into the centralized farm. A passage-house is one in which a long passage runs crosswise though the house's growing number of rooms. The centralized farmstead is really just a continuation of the passage-house (Gad 1970) consisting of a huge block of dwelling rooms (Jansen 1972). The centralized farm fulfilled the same functions as other farms except all of the different buildings were under a common roof (Andreasen and Arneborg 1992). Gad (1970) suggested the centralized farmstead was developed as a result of the cooling climate and the need for greater insulation and heating efficency. Since turf buildings stand for approximately fifty years, Norse farms such as GUS had to be rebuilt several times giving opportunity for the structure to be reconstructed and rearranged.

Six building phases have been defined at GUS (Figure 17) as of the 1995 field season. During the 1996 field season more rooms where discovered including the long house structure which is thought to date to the 1100's (Jette Arneborg, Danish National Museum, personal communication, 1996). Until the stratigraphy and building phases are finalized for the GUS site all sample interpretations are preliminary. While it is uncertain, there may have been buildings or rooms associated with an earlier, pre-longhouse time period (Jette Arneborg, personal communication 1996).

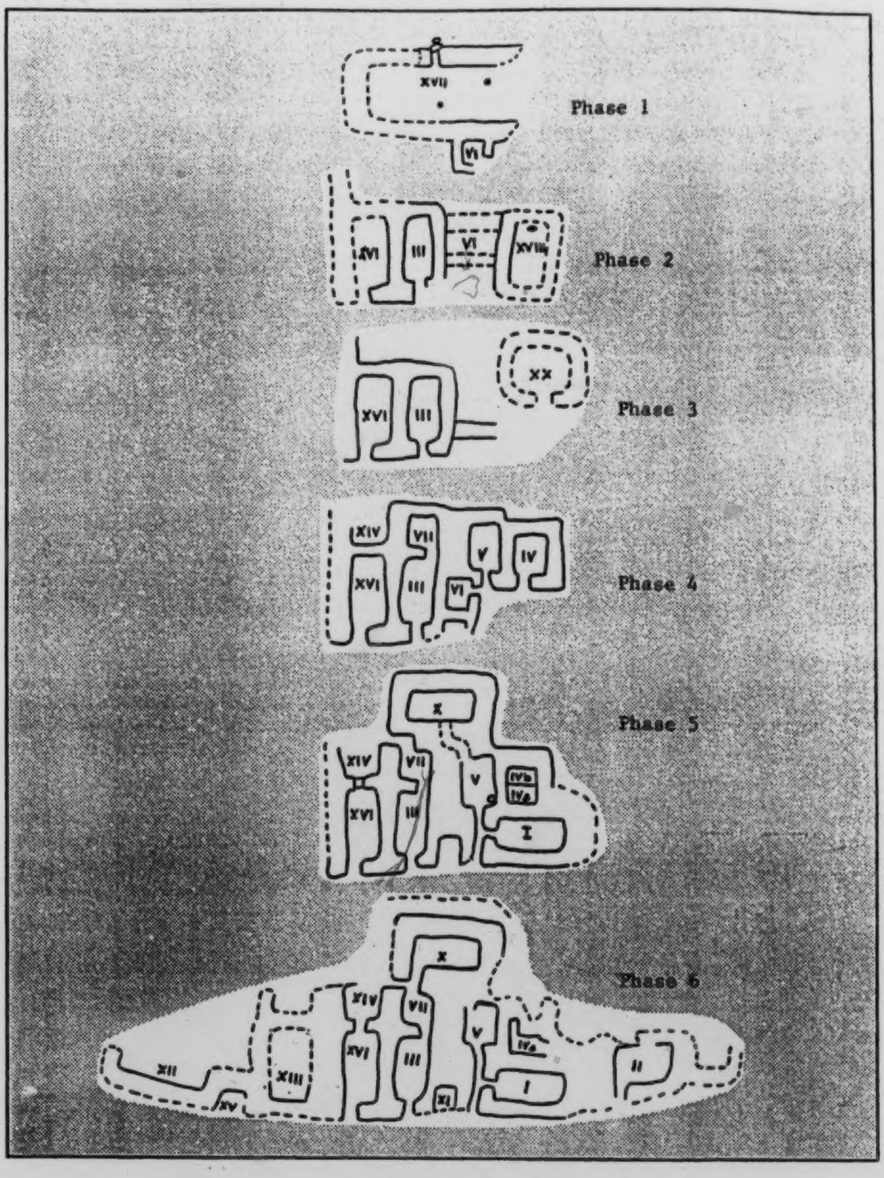

XVII
Phase 1
VI
XVI
III
VI
XVIII
Phase 2
XX
XVI
III
Phase 3
XIV
VII
V
IV
XVI
III
VI
Phase 4
X
Phase 5
XIV
VII
V
IVb
IVa
XVI
III
I
X
Phase 6
XIV
VII
V
IVa
XII
XIII
XVI
III
II
XV
XI
I

Figure 17. Construction phases and room numbers, GUS farm. Reprinted by permission from Arneborg 1996a.
NOTE: The described phases are preliminary.

CHAPTER 4 ARCHAEOBOTANICAL METHODS

4.1.0. Samples in Relation to Sampling Universe

The archaeobotanical sampling at GUS is by far the most extensive done to date in Greenland. One hundred and thirty-nine samples were collected, including samples taken from within the building structure as well as from the surrounding area (Appendix 3). Samples taken within the farmstead were identified in reference to the excavation grid which was established in 1990 over the data universe, the area of the GUS farm. Grid units, 4X6 m, were assigned letters for identification. Not all grid units have samples. Most of the samples taken were assigned a four digit find number and plotted on plan drawings of the site. The depths, relative to the datum point which was fixed on a large boulder NW of the excavated area, were determined using an engineer's level. The datum was assigned a value of 10 metres and all the sample depths referred to are below this datum (B.D.). Samples that were thought to relate to the paleoethnobotanical and geoarchaeological aspect of the project were also collected. These samples, were not given find numbers and are identified by the collector, Sch for Dr. C. E. Schweger and JR for author. Figure 18 depicts the sampling units and the number of samples which were examined.

↖N								
504m				AA				
508m		Ø	V 1	R 2	N 1	J	AB	AC
512m		Æ	U	Q 7	M 3	H		
516m		Z	T 5	P 10	L 1	G 2		Unknown: 7
520m	Y	X	S	O	K	F		Profiles: P-T: 3
	1078m	1072m	1066m	1060m	1054m	1048m	1042m	1036
River	River	River	River	River	River	River	River	River

Figure 18. Archaeobotanical samples analyzed in reference to grid Letters identify grid units, numbers refer to number of samples collected. Bold lines indicate where stratigraphic profiles were sampled.

4.2.0. Archaeobotanical Field Methods

Archaeobotanical samples were collected from cultural features identified by archaeologists at the site. Features included living floors associated with humans and animals, postholes, barrels, cooking areas, turf blocks, peat blocks and animal fecal material (Appendix 3). It is difficult to distinguish between goat or sheep droppings so any fecal material possibly related to these animals are grouped together and referred to under the more general term caprine. Both column and composite samples were collected using established methods (Pearsall 1989). The complex stratigraphy of cultural features often made it difficult to establish with certainty when new cultural levels had been reached. In such cases, column samples were taken after profiles had been drawn and stratigraphic correlation across the site had been established. Composite samples were collected as a scatter of sediment from individual features (Pearsall 1989). These samples were collected when a feature could be easily identified during the excavation process.

During the 1995 field season, five litre samples were collected and wet screened on site through number 20 (850 μm) and 40 (425 μm) mesh screens to reduce volume and facilitate transportation (Pearsall 1989, Wagner 1988). This screening was carried out in a cold glacially derived braided river. Screening was done carefully and river water was not allowed to enter the screens from above. Any fresh, unstained modern seeds would be easily recognizable during later microscope analysis. During laboratory analysis in 1995, it was decided that important information such as large twigs, sediment characteristics, and sediment chemistry had been lost by screening the sample in the field. To prevent further loss of information of this kind the sample procedure was changed. However, the sample size had to be reduced to permit affordable transportation to Canada where they could be screened. A two litre sample was considered an adequate compromise and was collected during the 1996 field season. Forty-two samples from 1995 and 1996 were selected for laboratory analysis (Figure 18).

4.3.0. Archaeobotanical Laboratory Methods

The 1995 field-screened samples created difficulties in subsampling for macrofossil analysis and later interpretation. The loss of volume during screening was highly variable and so samples were not directly comparable with regard to size and seed concentrations. To minimize this problem the 1995 samples were spread out and divided into 16 parts using the grid method (Van der Veen and Fieller 1982). As seed counts from one sixteenth were in the thousands, these samples were subdivided into one/thirty-second portions. Roughly 155 ml (5,000 ml 1/32) of each sample was examined. Samples indicated by an * when presenting the results had larger fractions examined. It is felt that redundancy was achieved in each sample as after approximately half of a subsample had been picked for seeds no new taxa were discovered.

Smaller 2 litre (2,000 ml) samples were collected during the 1996 field season. For picking, these samples were divided into 100 ml subsamples. It was decided to use only 100 ml as opposed to 155 ml as I wanted the 1996 data to be comparable with that of other paleoethnobotanical researchers (Buckland *et al.*1983). Subsamples were wet screened in the laboratory through a number 40 (425 µm) mesh screen to remove any fine inorganic sediment and concentrate the organic remains.

The waterlogged nature of the material from GUS precluded flotation for separating organic material from inorganic material. Instead the screened matrix was examined under a low-powered stereo microscope at X120 magnification and identifiable material such as seeds and leaf buds were removed by hand. After identification and enumeration each taxon was stored in its own vial. Each complete macrofossil was counted, as were fragmentary remains. Following the procedures of the Natural Science Unit of the Danish National Museum, five fragments were considered to equal a whole seed. The term seed in this text is used as general term including all fruit types such as drupe, stone, achene, berry, caryopsis. A final check was made to ensure that the seeds were correctly identified and to assess if a more specific taxonomic determination could be established. Finally the samples are curated in the Laboratory for Paleoenvironmental Studies, Department of Anthropology, University of Alberta.

Seed identifications were made by myself by comparing the GUS material with seed reference collections, at the Natural Science Research Unit, Danish National Museum and the Botanical Museum, Copenhagen University. Drs. David Robinson and Bent Fredskild supervised my work at their respective laboratories. A subsample of the latter collection was loaned to the University of Alberta, Paleoenvironment Laboratory to facilitate this project. Standard seed identification manuals (Beijerink 1947; Berggren 1969; Delorit 1970; Martian and Barkely 1961) were also used to supplement the seed reference material. Appendix 4 contains SEM photographs of the most common taxa found with supplementary descriptive text. The nomenclature follows *The Flora of Greenland* (Böcher *et al.* 1968). Identifications range from the family to the species level depending on the fragmentary condition of the material, the references material available and my confidences level.

4.4.0. Pollen

Pollen samples were collected from both modern and archaeological contexts (Appendix 3). Analysis was carried out on 13 samples, three from Room 3 and the remaining are from Norse cow and caprine manure.

Standard pollen processing procedures of the University of Alberta Paleoenvironment Labratory were employed based on Fægri and Iversen (1975). The processing of these samples also involved the use of heavey liquid

($ZnBr_2$), HF and Acetolysis. The residue was mounted on slides using silicon oil and the cover slips were sealed with nail polish. The slides contained extraneous organic matter, creating difficulties in identifying grains as organic debris often obscured the view. Unfortunately, the pollen was not stained. This would have greatly assisted identification of the pollen and I highly recommend the use of stains in the future. Pollen grain identification was assisted by using the reference collection and advice of the staff at the Laboratory of Paleoenvironment Studies, University of Alberta and reference books (Kremp 1968; Moore and Webb 1978). Pollen concentrations from dung samples were low and complete slides had to be counted (Appendix 5). Even then most slides contained only one hundred grains, some had even lower counts. It is acknowledged that the pollen counts are relatively low.

4.5.0. Grouping of Data

The archaeobotanical remains are divided into seven artificial paleoethnobotanical groups based on vegetation land-use to aid presentation and interpretation of results. The Heath/Outfield group includes those taxa found in dwarf-shrub vegetation including Ericaceous dwarf shrubs and *Betula nana*; *Alnus crispa* and *Salix* sp. are also included in this group as they are woody species [Böcher *et al.* (1968) group *Alnus crispa* and *Salix* sp. in a copse community]. *Empetrum nigrum*, *Polygonum viviparum*, *Vaccinium vitis-idaea*, *Luzula* sp., leaf buds, leaves, *Potentilla crantzii* and *Taraxacum* cf. *croceum* are all also included in the Heath/Outfield group. The Wetland group combines fen and bog vegetation which includes members of Cyperaceae family such as *Eriophorum* sp. and *Carex*. *Carex* seeds are divided into two morphological categories lenticular and trigonous. In addition to the Cyperaceae this group also includes *Epilobium* sp. and *Juncus* sp. The Ponds, Puddles and Lake margins group includes *Potamogeton* sp., *Hippuris vulgaris*, *Ranunculus confervoides*, and brood pouches of a Crustacea Cladocera *Daphnia ephippia*.(Clifford 1991). The Apophyte group includes plants (weeds) that benefit from human activity such as *Montia fontana* and *Chenopodium* sp. The Anthropochore group includes plants (weeds) that were introduced into an area and are reliant on human activity. *Capsella bursa-pastoris*, *Stellaria media*, *Polygonum aviculare* and *Polygonum convolvulus* are inclusive of the introduced weeds (Böcher *et al.* 1968; Fredskild 1989; Pedersen 1972) that were found in the GUS archaeobotanical assemblage. The Miscellaneous group includes plant remains which could not be identified to a sufficiently high taxonomic level for an ecological designation to be assigned. A Grass group was formed to acknowledge the importance's of grasses and their likely exploitation (Appendix 4) (Boniface 1981, Böcher *et al.* 1968, Bent Fredskild, Greenland Botanical Survey, Botanical museum, University of Copenhagen, personal communication 1995; Pedersen 1972).

CHAPTER 5 RESULTS

5.1.0. Macroremains

The research team involved in the analysis of all the data from the GUS site is inter-disciplinary; the results presented here are of a preliminary nature as some of the other inter-disciplinary data may modify the information available at this time. Of the 42 samples analyzed, 31 were investigated for macroremains (sample 2586 was examined for both pollen and macroremains, and dung inclusion in sample 3264 was treated as a separate sample so the results are based on 44 samples). The raw data from GUS is presented in chronological order based on preliminary building phases and room use starting with samples from the oldest part of the site. This is followed by samples which are not associated with a specific building phases such as building material and manure.

Sample #	Room	Building phase	Use
3167,3039, 2727, 3216, 2830,2823,3160, 3264	Long House (Room 27)	1	living space
2267	Room 1	6	weaving room
2463, 2464, 2465, 2544, 2470, 2424, 2417, 2610, 2609, 2425	Room 3	6	cow byre
2484	Room 4a		living space/
2283	Room 4a	6	sheep cotes
2266	Room 4b	5	living space
2602	Room 6	4	living space
2450	Room 7	6	sheep stable
2624, 2604	Room 19	unknown	living space
2417	unknown	unknown	unknown

Table 2. Relative ages of samples based on room construction.

While counts for some species will be indicated in the text, all of the results are expressed as raw counts in Appendix 5. The data are presented in pie diagrams based on five of the seven arbitrary groups (Section 4.5.0); the Miscellaneous and Pond, puddles and lake margin groups have been excluded. Where possible, these pie diagrams will be presented in relation to their specific location in a room, or within a building phase. When a specific plant is referred to the Latin name is used. For the readers unfamiliar with this system a list of Latin, English, Danish and Greenlandic plant names is provided in Appendix 6. Photographic documentation was made for 25 of the most common plant remains and can be found in Appendix 4. The samples in this chapter are identified by their find number followed by the room or area association (e.g., 3167/Rm27).

Macroremains were abundant and generally well preserved due to the waterlogged nature of the site; some seeds had been charred. In addition to seeds, mosses, twigs and non-identifiable plant fragments were also found. The non-botanical material included clastic material, insect parts, bone fragments and the occasional material culture remains (e.g., twine, cinder). Preservation was good throughout but some variation existed between samples and taxa. The preservation of seeds from Rooms 1, 3, 4a , 4b ,6, 7, and 19 is excellent (Table 2). Samples determined to be construction material exhibited variable preservation but was generally good. Plant remains from the long house samples were less well preserved. Whether this is due to the burning of the long house or because the samples originate from an older context is unknown. In total 36 taxa representing 16 families were identified for all samples amounting to 21,040.3 individual remains identified and enumerated.

5.1.1. Long House

The eight long house samples contained a significant quantity of unidentified plant fragments consisting of plant stems and leaf fragments. Identifiable macrofossils range from 125 to 684 per 100 ml. Four samples were interpreted on site as floor layers (3167/Rm27, 3039/Rm27, 2830/Rm27, and 2823/Rm27) as well as a construction layer (3160/Rm27), the central hearth (3216/Rm27), cooking area (2727/Rm27) and a burnt "grass" (3264/Rm27) sample.

The floor samples do not exhibit a unique pattern as each floor sample is dominated by a different macroremains group. Samples 3039/Rm27 (Figure 19) and 2830/Rm27 (Figure 20) are dominated by Wetland species followed by species from the Heath/Outfield group. Heathland/Outfield remains dominate in 3167/Rm27 (Figure 19) making up over fifty percent of the sample, followed in frequency by Wetland and Grass groups. The botanical remains from sample 2823/Rm27 (Figure 21) are fairly evenly distributed among Heath/Outfield, Anthropochore and Wetland groups.

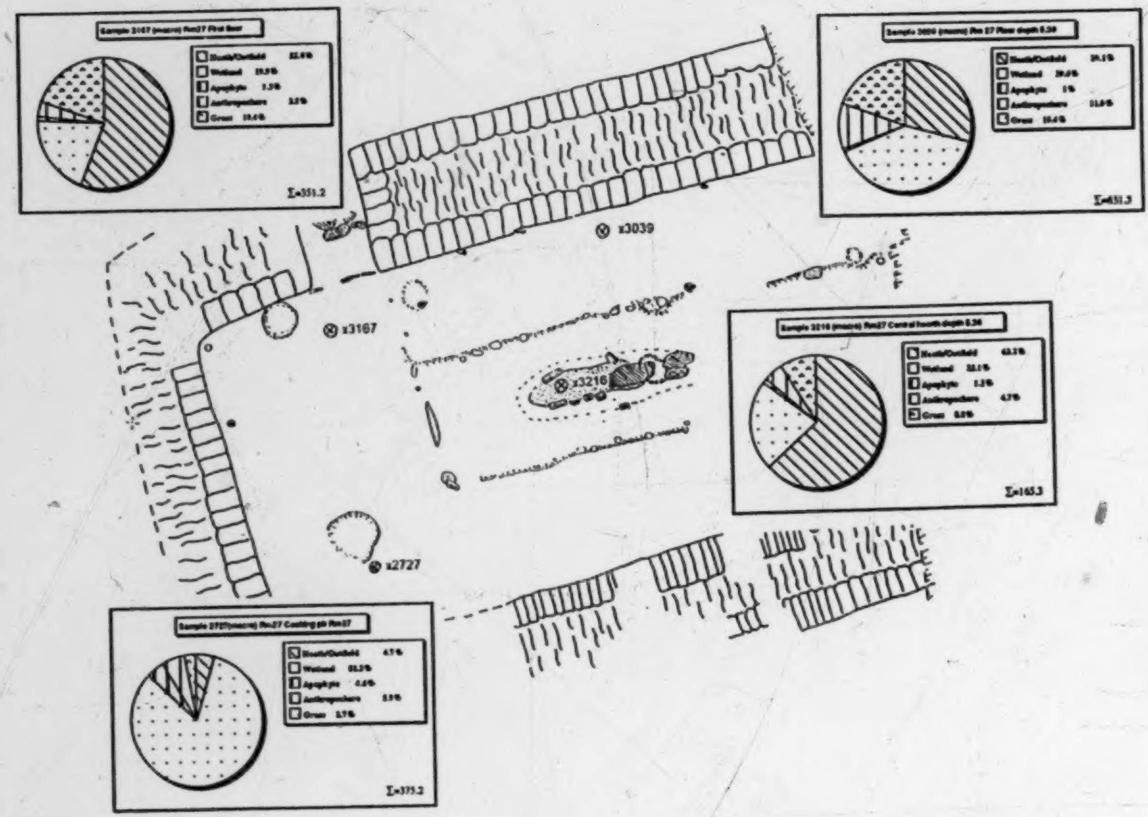

x3039
x3167
x3216
x2727
Σ=351.2
Σ=451.3
Σ=165.3
Σ=375.2

Figure 19 Room 27, long house, pie diagrams for samples 3167, 3039, 2727 and 3216. [plan drawing] Adapted from Ross in press

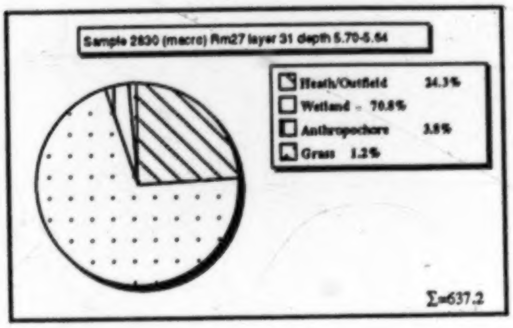


Figure 20. Room 27. long house, pie diagram for sample 2830.

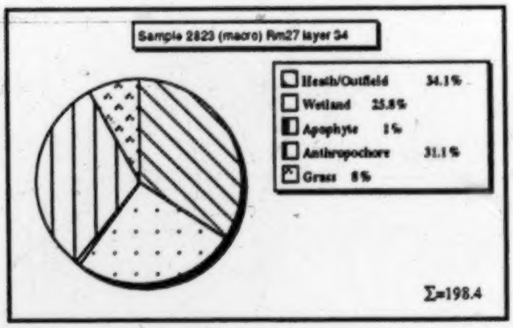


Figure 21. Room 27, long house, pie diagram for sample 2823.

The Heath/Outfield group in sample 2830/Rm27 is dominated by *Luzula* sp. and *Vaccinium vitis-idaea*. This is also the only sample with remains of *Eriophorum*. *Vaccinium vitis-idaea* is common in sample 3167 and a *Thymus*-type seed was also found.

The construction level (3160/Rm27) (Figure 22) is dominated by Heath/Outfield species. The only evidence of *Juniperus* (one needle) from the long house is found in this sample.

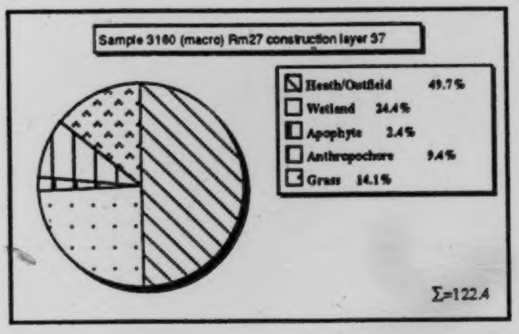


Figure 22. Room 27, long house, pie diagram for sample 3160 (construction layer).

The long house hearth (3216/Rm27) (Figure 19) is dominated by Heath/Outfield species including leaf buds of the Salicaceae and/or Betulaceae family. Seeds from the Cyperaceae family represent 22.1 percent of the sample, the second most abundant taxon.

Sample 2727/Rm27 (Figure 19) was taken from an area interpreted during excavation as a cooking pit. This sample is dominated by the Wetland group (82.2%).

Sample 3264/Rm27 (Figure 23), identified in the field as grass, is dominated by Gramineae (41%) and Cyperaceae seeds (40.6%). Field identification of this sample as grass stems was partially incorrect, an understandable mistake as charred fragments of Cyperaceae and Gramineae plants would not be readily distinguishable. Dung pellets were also examined from this sample but are considered separately in the manure section. A tiny piece of what appears to be a cinder fragment is in this sample.

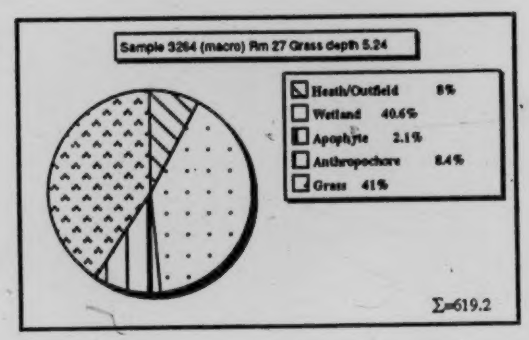


Figure 23. Room 27, long house, pie diagram for sample 3264 (grass).

5.1.2. Living Rooms

Sample 2602*/Rm6. contains very few macro remains most of which are *Carex* sp. with the Apophyte group making up 10.7 % of the sample (Figure 24). Sample 2484/Rm4 (Figure 24) is dominated by Anthropochores (44%) most of which are *Capsella bursa-pastoris* and Grasses (29.2%). Sample 2484/Rm4 also contains higher counts for *Vaccinium vitis-idaea* (72), *Empetrum nigrum* (46), and *Polygonum convolvulus* (11.4) than do the other living rooms. Sample 2266*/Rm4b is dominated by the Anthropochore group (70.5%) due to an abundance of *Capsella bursa-pastoris* (Figure 24). Macroremains from 2266*/Rm4b are notably different from other rooms. Sample 2266*/Rm4b contains the highest number of *Polygonum viviparum* remains (270) in the whole sample set and high numbers of *Montia fontana* (255) (Figure 25). The numbers of finds of *Potentilla crantzii* (57), *Rhinanthus* sp. (37) and *Polygonum convolvulus* (9) are also higher than in the other living room sample assemblages. Sample 2283/Rm4a is dominated by Anthropochores (48.4%) followed by Grasses (22.7%) (Figure 26). Sample 2267/Rm1 (Figure 26) is dominated by Anthropochores (41.8%), followed by plants in the Wetland group (32.3%).

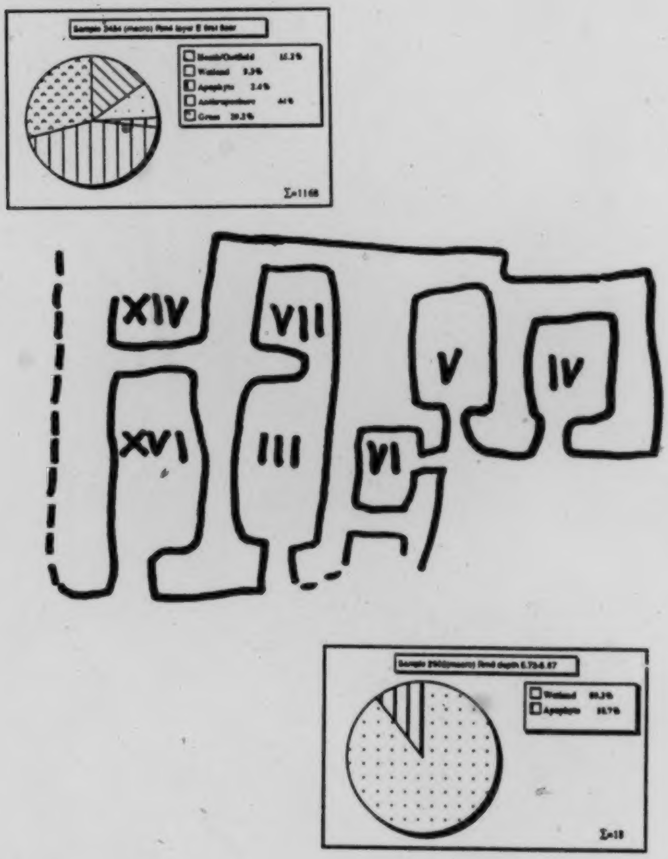


Figure 24. Building phase 4, pie diagrams for samples 2602/Rm6 and 2484/Rm4.
[plan drawings] Adapted from Arneborg 1996a.

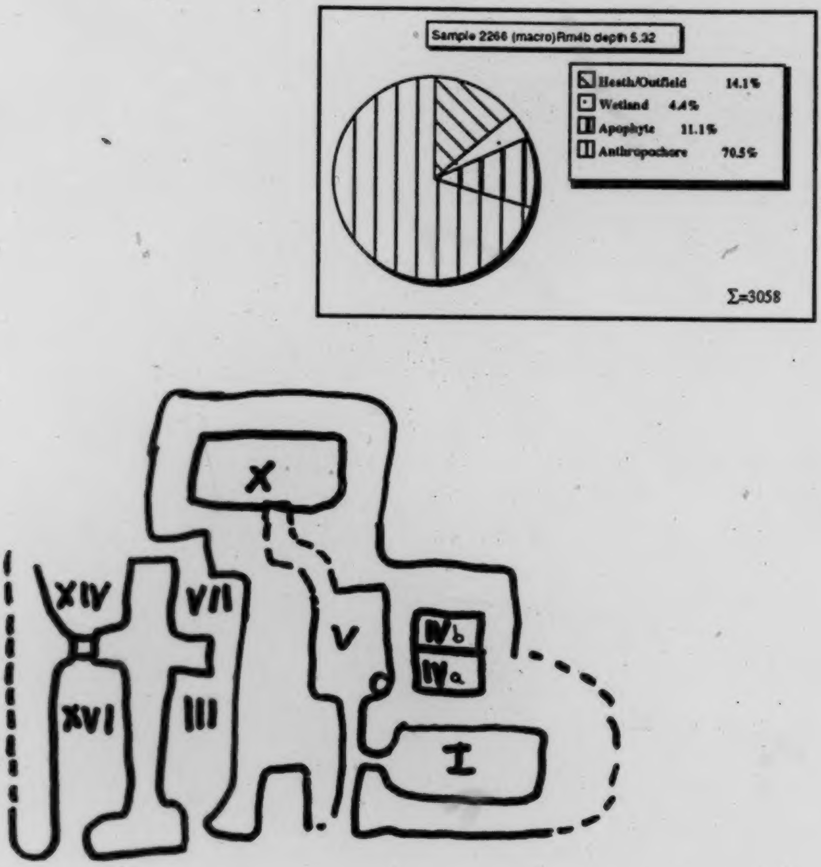


Figure 25. Building phase 5, pie diagram for sample 2266/Rm4b. [plan drawings] Adapted from Arneborg 1996a.

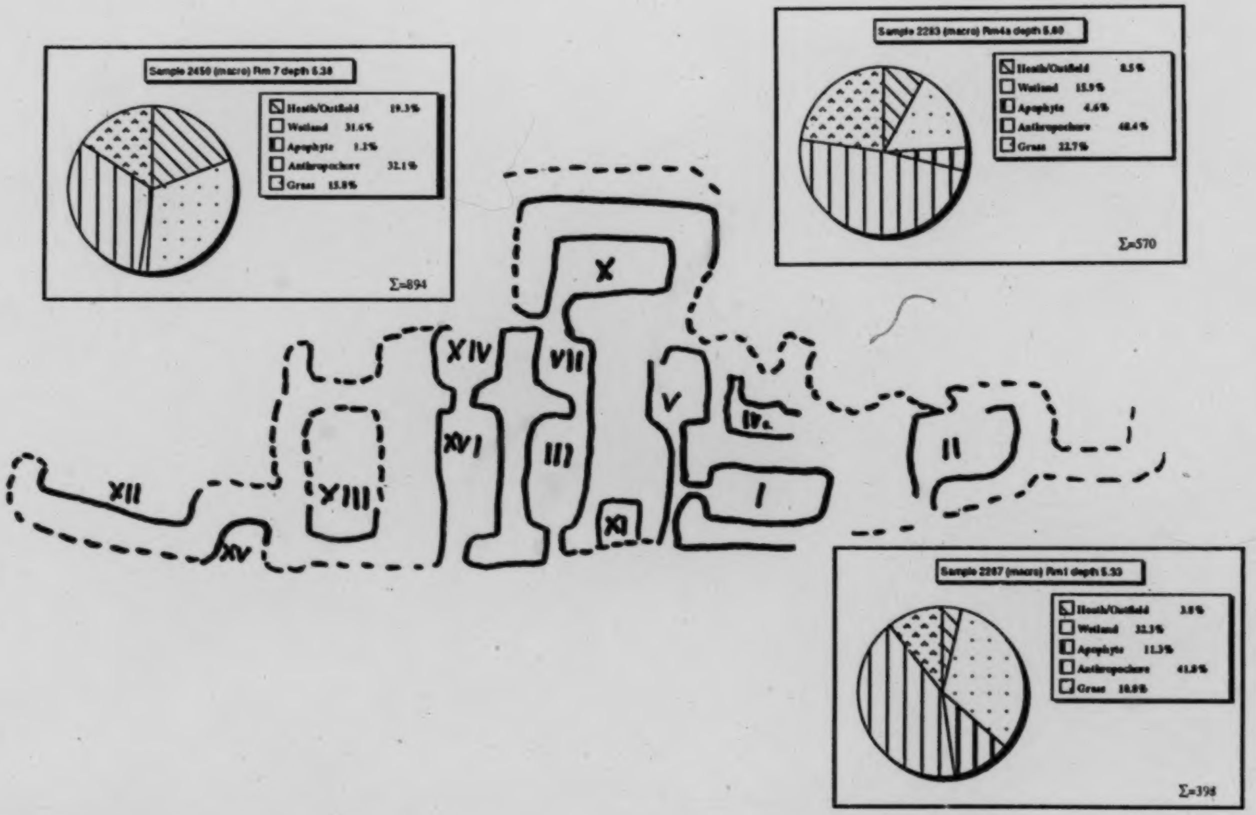


Figure 26. Building Phase 6, pie graphs for samples 2267/Rm1, 2283/Rm4a and 2450/Rm7. [plan drawings] Adapted from Arneborg 1996a.

Sample 2624*/Rm19 is dominated by Wetland plants (38.8%) followed by Anthropochores (33.6%) (Figure 27). *Vaccinium vitis-idaea* (95), *Hippuris vulgaris* (4) and *Polygonum convolvulus* (11) are found with relatively high numbers in this sample. The posthole 2604*/Rm19 is dominated by plants from the Wetland group (44.9%) but has almost equal representation of remains from the Heath/Outfield (17.9%), Anthropochore (16.5%) and Grass (16.6%) groups (Figure 28). In sample 2604*/Rm19 total counts for *Vaccinium vitis-idaea* (36) and brood pouches of *Daphnia ephippia* (21), compared to other samples are high. Preservation of material from the posthole is poor (Figure 28); this will be discussed later (6.2.2).

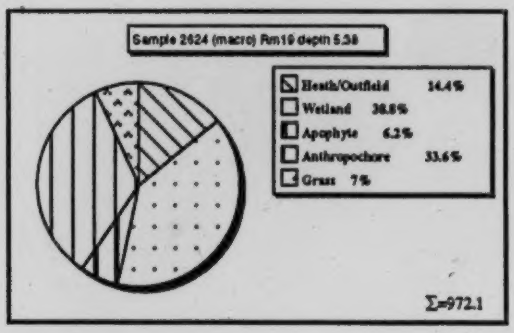


Figure 27. Room 19, pie diagram for sample 2624.

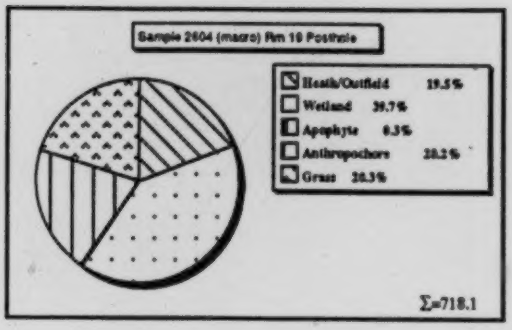


Figure 28. Room 19, pie diagram for sample 2604 (posthole).

Sample 2417 (Figure 29) was designated in the field as belonging to the long house but this designation is no longer valid (Jette Arneborg, personal communication 1997). Unfortunately, at this time no other room association can be made. The sample is dominated by Anthropochores (39.8%) which are followed by Grasses (31.1%).

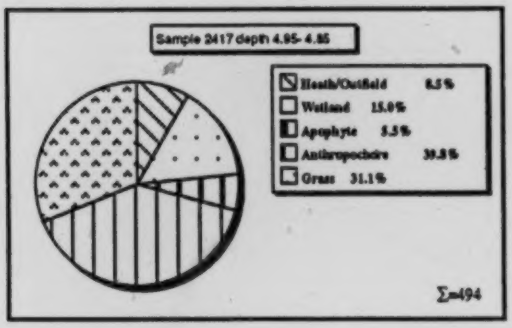


Figure 29. Unknown room, pie diagram for sample 2417.

5.1.3. Animal Rooms

Rooms 7 and 3 were designated in the field as being associated with housing sheep and cows, respectively. Sample, 2450*/Rm7 is dominated by plants of the Anthropochore group (Figure 26). This sample contains relatively high counts of *Vaccinium vitis-idaea* (53), and *Hippuris vulgaris* (9) compared with other GUS samples.

Floor samples 2544/Rm3, 2470*/Rm3, 2424/Rm3, 2610/Rm3 and 2609/Rm3, and a feeding trough sample 2425/Rm3 were collected from the cow byre (Figure 30). The total number of macrobotanical remains in these samples range from 338 (2544/Rm3) to 2504 (2470*/Rm3). In five of the six samples, Anthropochores dominate with *Capsella bursa-pastoris*, followed by *Stellaria media* being the most common taxa. Seeds from the Grasses are next in abundance, except for 2544/Rm3 where the Apophyte group substitutes. Sample 2609/Rm3 is dominated by plants in the Wetland group followed by Anthropochores.

A more detailed look at these samples reveals that *Montia fontana* is about ten times more prevalent in samples 2470*/Rm3, 2424/Rm3 and 2425/Rm3 than in the other byre samples. *Ranunculus sp.* has a high count (79) in sample 2544/Rm3; otherwise it ranges from 1 to 17 in the other byre samples. Sample 2425/Rm3 has higher counts of *Polygonum viviparum* (18) and *Rhinanthus* sp. (31) than the other byre samples. *Polygonum viviparum* and *Rhinanthus* sp. counts range up to 7 and 13, respectively, in the other byre samples. A *Thymus*-type seed was found in sample 2609/Rm3.

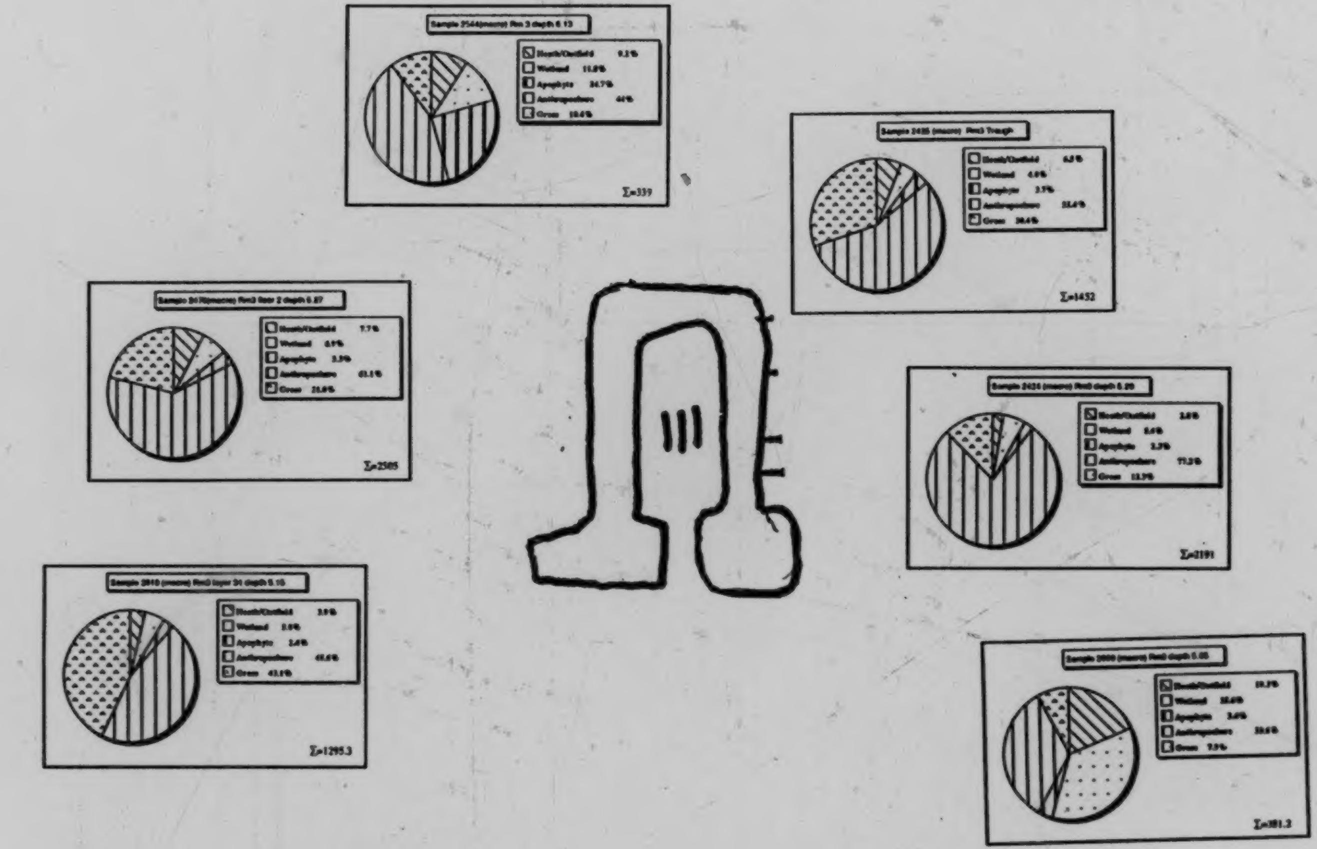


Figure 30 Room 3, Cow byre, pie diagrams for samples 2544, 2470, 2424, 2610, 2609 and 2425 [plan drawing] from Arneborg 1996a

5.1.4. Manure

Manure samples were investigated using both macrobotanical and pollen analysis (Table 3).

Sample #	Species	Analysis	Room / Area
3264	caprine	macro	27
JR13.96	caprine	pollen	16
JR9.96	caprine	pollen	16
3297	caprine	pollen	25
3158	caprine	pollen	27
3229	caprine	pollen	23
2586	caprine	macro	Q
		pollen	Q
Sch8.7.96.4	cow	pollen	4
Sch10.7.96.2 cow	pollen		
2456	cow	macro	P
3454	cow	pollen	19
JR 20.96	cow	pollen	16

Table 3. Caprine and cow manure samples.

Caprine dung samples 3264/Rm27 and 2586/Q were investigated for macrobotanical remains (Figure 31). Both samples are dominated by species of the Wetland group, followed by the Heath/Outfield group.

Sample 2456/P (Figure 32) was investigated for macrobotanical remains. Only three fragments of Gramineae were recovered from a matrix of dark, amorphous organic material.

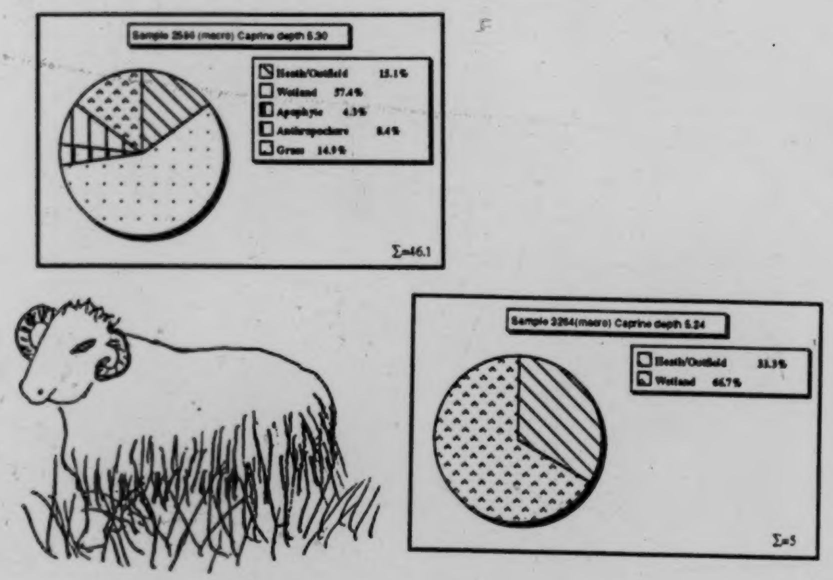


Figure 31. Caprine, pie graphs for samples 3264/Rm27 and 2586/Q.

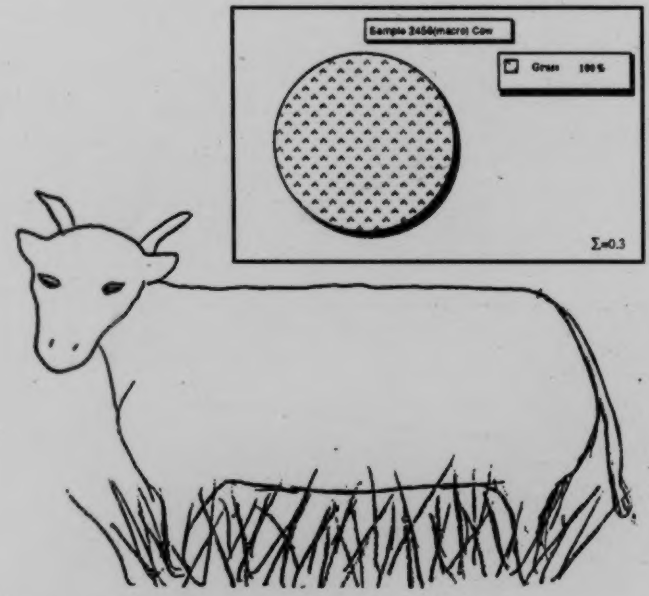


Figure 32. Cow, pie graphs for samples of 2456/P.

5.1.5. Construction Material

Four samples (Figure 33) were designated as building material, peat blocks 2618/G and 2343/Q, a turf block 2319/Q and a wall construction fill layer 2334/Q composed of manure. Macroremains totals varied greatly, ranging from 37 to 641 in samples 2618/G and 2319/Q, respectively. The turf block sample 2319/Q consists mostly of mosses and unidentifiable plant material. Identifiable remains are mostly leaf buds thought to be from Salicaceae family and grass seeds. Peat block sample 2343/Q contains mostly Wetland (41%) and Heath/Outfield (30.9%) taxa. *Capsella bursa-pastoris* seeds made up half the total from the peat block sample (2319/Q), resulting in the Anthropochore group making up 52.7% of the sample. Cyperaceae and Gramineae are next in abundance having percentages of 26.4 and 10.4, respectively. The manure construction material (2334*/Q) is composed of roughly equal proportions of Anthropochore, Heath/Outfield and Wetland groups. This sample also has a high number of *Hippuris vulgaris* remains(9).

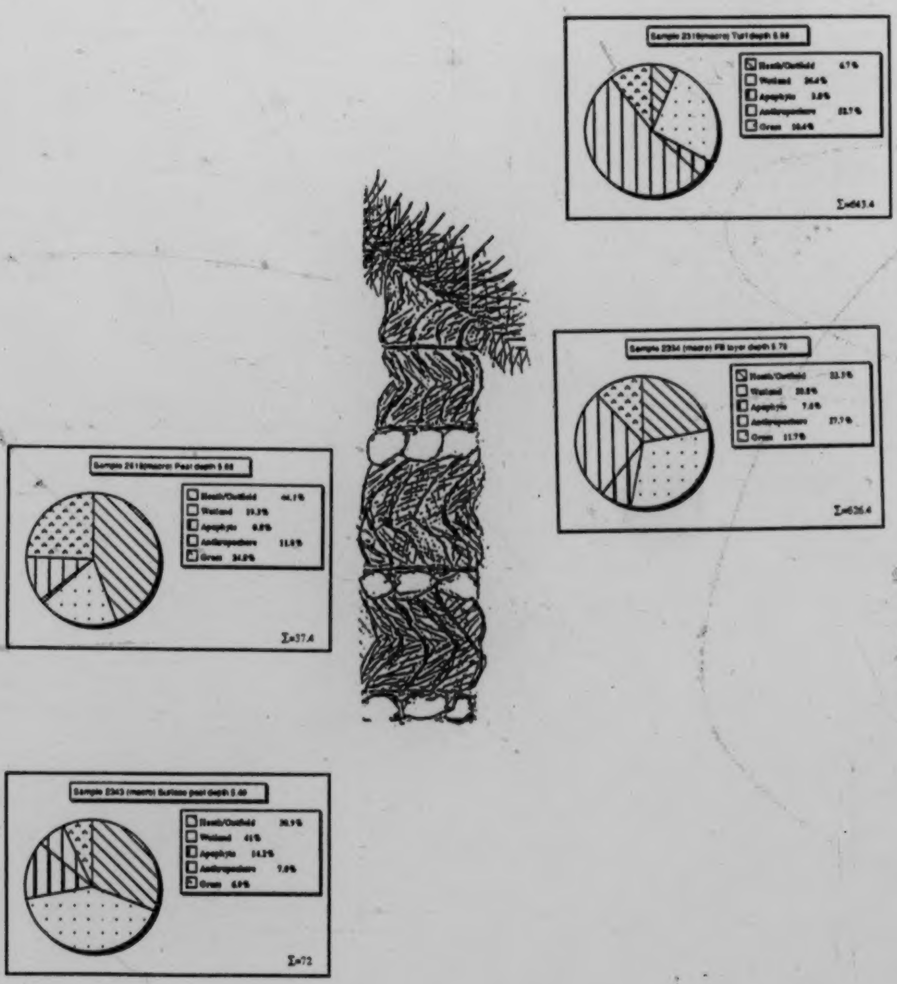


Figure 33. Construction material, pie diagrams for samples 2334/Q, 2343/Q, 2319/Q and 2618/G.

5.2.0. Pollen

Thirteen of the 44 samples analyzed were examined for pollen. Three samples from the cow byre, Room 3, were examined. Although the preservation was good the considerable amount of organic debris made identification difficult. Ten dung samples were examined but the material on the slides was very sparse making a minimum count of a hundred difficult or impossible. All of the counts are in Appendix 5.

5.2.1. Room 3

Pollen samples 2463/Rm3, 2464/Rm3 and 2465/Rm3 were taken from the P-T profile plan (Figure 18) and range in depth from 5.65 to 5.56 m B.D. Pollen counts range from 88 to 100 and all samples are dominated by plants from the Heath/Outfield group followed by Gramineae in samples 2463/Rm3 and 2464/Rm3, and Cyperaceae pollen making up the Heath/Outfield group in sample 2465/Rm3 (Figure 34).

5.2.2. Manure

Caprine manure samples analyzed for pollen included JR9.96/Rm16, JR13.96/Rm16, 3229/Rm23, 3297/Rm25 and 3158/Rm27 (Figure 35). The pollen composition of five of the six samples is dominated by the Heath/Outfield group. The exception, sample 2586/Q, was dominated by Grasses (62.5%)

followed by Heath/Outfield (25%). Grass is second in abundance in samples JR9.96/Rm16, JR13.96/Rm16 and 3297/Rm25. In sample 3158/Rm27, pollen of Wetland and Grass groups each equal 3.8% of the sample. Anthropochores (12.6%) are the sub dominant group in sample 3229/Rm23.

Cow dung samples 3454/Rm19, JR20.96/Rm16, Sch8.7.96.4/Rm4, and Sch10.7.96.2/Unknown (Figure 36) were analyzed for pollen. In three of the four samples the Grass group makes up fifty percent or more of the sample, followed in prominence by the Heath/Outfield group. Sample JR20.96/Rm16 is the only sample dominated by Heath/Outfield group (78.8%), followed by Grasses (21.2%)

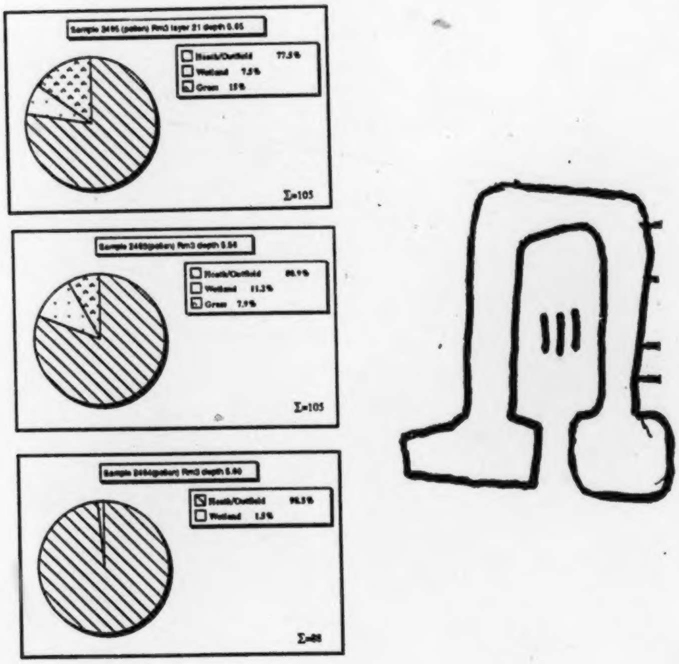


Figure 34. Room 3, cow byre, pie diagrams for samples 2463, 2464 and 2465. [plan drawing] Adapted from Arneborg 1996a

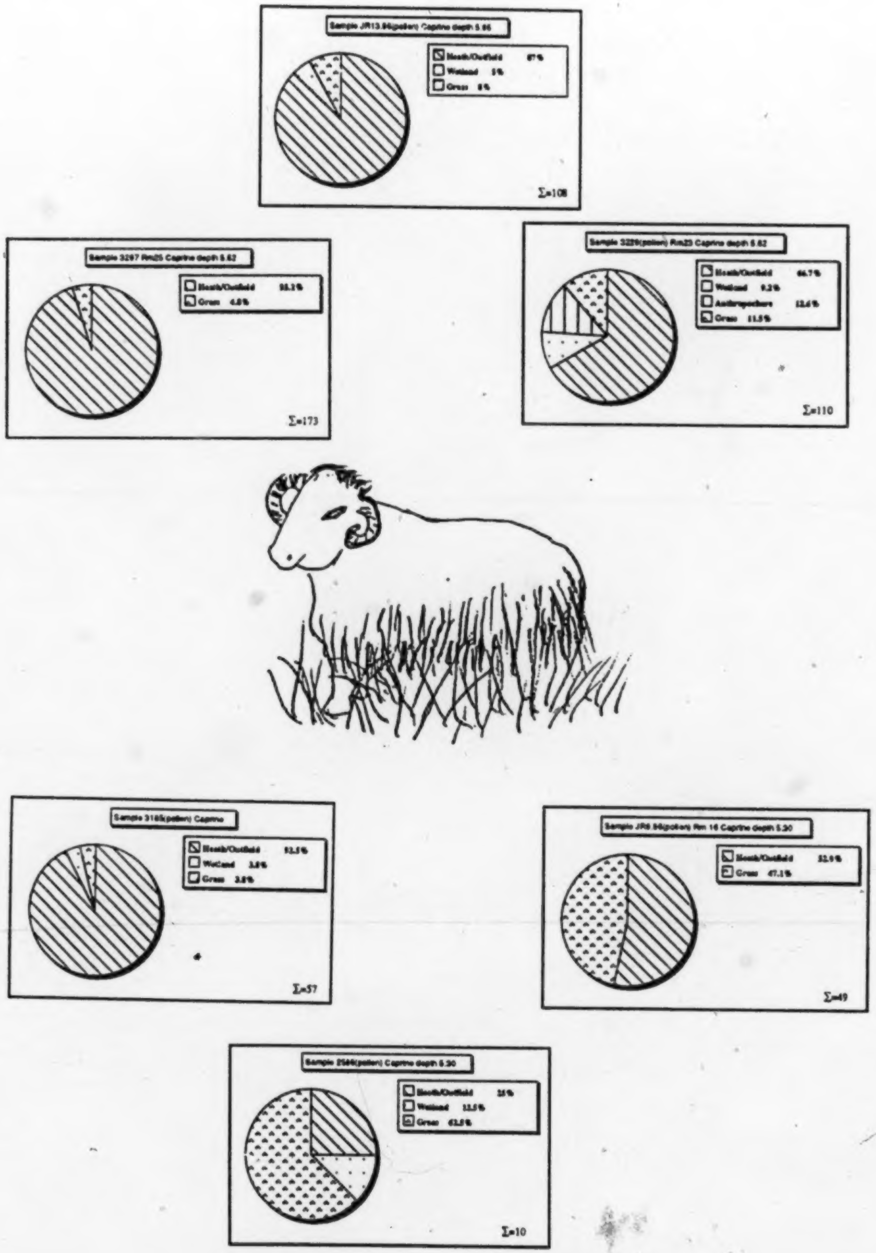


Figure 35. Caprine manure, pie diagrams for samples 2586/Q, JR9.96/Rm16, JR13.96/Rm16, 3229/Rm23, 3297/Rm25 and 3158/Rm27.

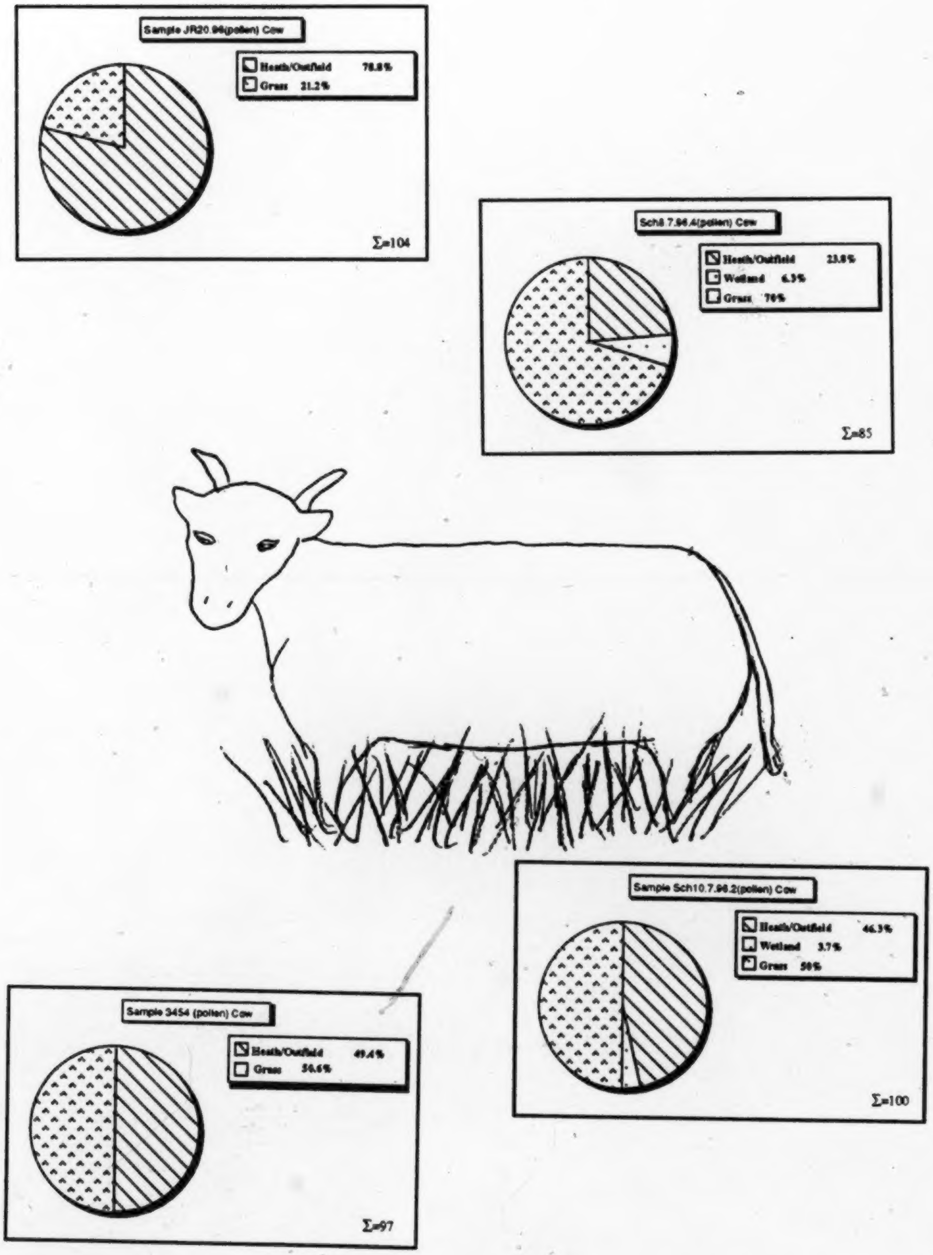


Figure 36. Cow manure, pie diagrams for samples Sch8.7.96.4/Rm4, 3454/Rm19, Sch10.7.96.2/Unknown and JR20.96/Rm16.

CHAPTER 6 FORMATION PROCESSES AND DISCUSSION

6.1.0 Formation Processes

A archaeobotanical assemblage is the result of formation processes similar to those that create and modify all archaeological assemblages. Formation processes shape the archaeobotanical record and, therefore, must be identified, and their effects explored before making interpretations. This section is divided into six parts: (1) the formation processes of archaeobotanical assemblages will be reviewed; (2) the formation processes involved in the creation of a archaeobotanical assemblage of a Norse Greenlandic farmstead will be considered; (3) problems inherent with the paleoethnobotanical record will be discussed; (4) benefits and limitations of a waterlogged assemblage, focusing on GUS, will be discussed; (5) formation process operating specifically at GUS will be discussed; and (6) how archaeobotanical sampling strategies can best be implemented to assist in solving the inherent problem of "noise" in paleoethnobotanical assemblages will be discussed.

6.1.1 Factors Affecting Archaeobotanical Assemblages

Archaeobotanical assemblages are produced as a result of formation processes that include natural and cultural transformations (Miksicek 1987; Schiffer 1987). Formation processes are defined by Schiffer (1987:7) "as factors that create the historical and archaeological record. Formation process are of two basic kinds: cultural, where the agency of transformation is human behavior; and non-cultural, in which the agencies stem from processes of the natural environment." Taphonomy is another approach to the formation of assemblages. According to Morlan (1980:30) taphonomy "include(s) all considerations bearing upon the passage of organic material from the biosphere to the lithosphere". In future discussion I include taphonomy with natural transformations. Formation processes result in the addition (input) and loss (output) of botanical material from an assemblage. In general, I have concluded that five stages describe the formation of an archaeobotanical assemblage from the time any plant part is brought to a site to the stage when the paleoethnobotanist identifies the remains (Figure 37).

The greatest number of botanical remains are introduced during site occupation and may be deposited through natural or cultural transformations. Minnis (1981), specifically discussing the introduction of botanical remains, further divides natural and cultural transformations into those which are the result of accidental introduction, indirect use or direct use. Accidental introduction includes a variety of natural transforms that incorporate remains of the vegetation present at the time of occupation such as, seed rain during occupation, accidental incorporation by animals, and by people via clothing or footwear. Introduction through indirect use refers to botanical remains which are components of raw material such as turf blocks, roofing material, flooring, or fuels. Direct use of botanical materials refers to plants that are intentionally or consciously collected, and/or harvested for processing and/or consumption (Minnis 1981).

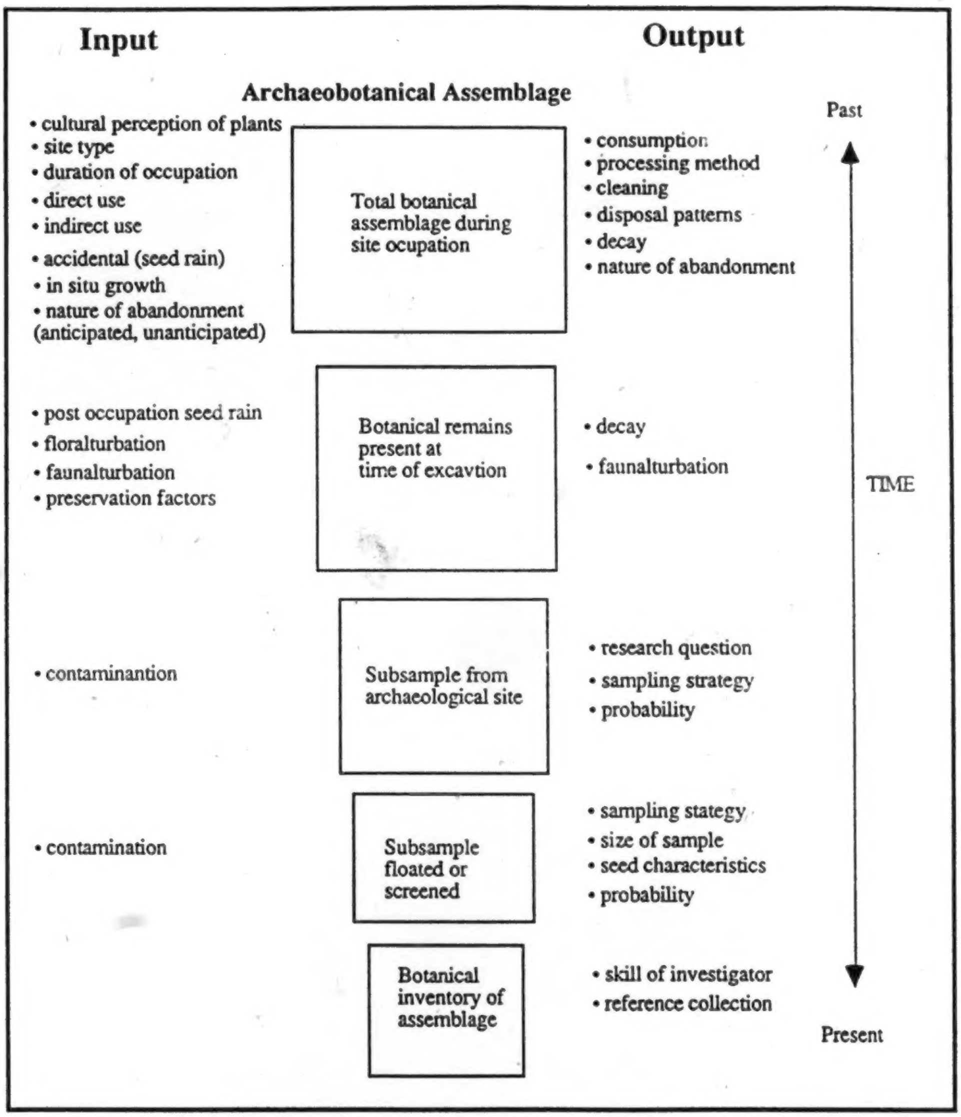

Input
Output
Archaeobotanical Assemblage
Past
• cultural perception of plants
• site type
• duration of occupation
• direct use
• indirect use
• accidental (seed rain)
• in situ growth
• nature of abandonment (anticipated, unanticipated)
Total botanical assemblage during site ocupation
• consumption
• processing method
• cleaning
• disposal patterns
• decay
• nature of abandonment
• post occupation seed rain
• floralturbation
• faunalturbation
• preservation factors
Botanical remains present at time of excavtion
• decay
• faunalturbation
TIME
• contaminantion
Subsample from archaeological site
• research question
• sampling strategy
• probability
• contamination
Subsample floated or screened
• sampling stategy
• size of sample
• seed characteristics
• probability
Botanical inventory of assemblage
• skill of investigator
• reference collection
Present

Figure 37. Five stages in the formation of an archaeobotanical assemblage through time (Botteman 1984; Clapham and Scaife 1988; Dennell 1976; Ford 1988; Hally 1981; Lennstrom and Hastof 1995; Minnis 1981; Miksicek 1987; Muson *et al.* 1971; Schiffer 1987; Van der Veen 1984; Wagner 1988; Wilson 1984).

All of the botanical materials incorporated into a site's matrix will be modified by processes of decay, the length of time and season that the site was occupied, as well as the cause and type of abandonment (Green 1982; Hally 1981). Plant materials accidentally incorporated into a site may be removed by cleaning episodes while indirectly used plants may be cleared out during repairs or cleaning episodes. Botanical materials used as fuel will either be disposed of or burnt beyond recognition. Any cleaning or disposal activity may simply result in botanical remains being relocated to an associated site or new area of the same site. Plants collected for direct use may be incorporated and then removed during processing or consumption (Begler and Keatinge 1979; Miksicek 1987; Schiffer 1987) (Figure 37).

At the time of excavation, the quantity and quality of botanical remains occurring within the site sediment are mostly dependent on natural transformations (Figure 37, second box). Whether an assemblage is carbonized, waterlogged, desiccated, or mineralized will influence the number and type of botanical materials preserved. Although, carbonization is in reality a "process of partial destruction" (Wilson 1984: 201), it is presented in the literature as a preservation mechanism. Carbonized archaeobotanical remains represent that portion which was not totally destroyed. The degree to which plant remains are destroyed is dependent on the specific characteristics of the fire, the individual characteristics of the plant species such as size, shape and chemical composition (Wilson 1984), and location of the seed in relation to the fire. Bioturbation may contribute to (input), or remove (output) remains from a site as well. Plants growing on the site at the time of and following abandonment may contribute a significant quantity of seeds to an assemblage. Miksicek (1987) showed that archaeological sediment from a British Iron Age site included 74 to 1,506 uncharred modern seeds. A Danish study recovered 135,000 modern weed seeds from a 1 m^2 plot of soil (Minnis 1981). A two year investigation of viable seeds at Eagle Lake, Iowa, a prairie marsh, recorded seed bank counts ranging from 565 seeds/m^2 to 56,289 seeds/m^2 for a 5 cm thick unit (Van Der Valk and Davis 1979). The Eagle Lake study demonstrates the great potential for naturally occurring seeds to find their way into an archaeobotanical assemblage and how the concentration of seeds depends on the surrounding vegetation community (Van Der Valk and Davis 1979). An experimental archaeological study from the American Southwest determined that from three different rooms within one site the seed counts ranged from 63 to 534. Of all these seeds only 5 were attributed to direct human use; the rest were incorporated into the site through natural transformations (Minnis 1981).

Since it is not logistically possible to process all the sediment from an archaeological site, much botanical material will be forfeited (Ball and Bobrowsky 1987; Robinson and Mikkelsen 1993; Van Der Veen 1984). The research question which structures the excavation strategy and influences what features are sampled, and the size of the samples, will constrain the recovery of archaeobotanical material (Miksicek 1987; Lennstrom and Hastof 1995; Robinson and Mikkelsen 1993; Van Der Veen 1984) (Figure 37, third and fourth boxes). Different processing methods (flotation or wet screening) will also affect the degree of fragmentation and types of taxa recovered (Green 1982; Pearsall 1987). Lastly, a point not often considered, the experience of the specialist analyzing the material as well as the limitations of reference collections available will influence the final taxonomic inventory of the archaeobotanical materials. In overview, the results of paleoethnobotanical research are influenced by five stages of formation processes which result in a greater discrepancy between the archaeobotanical assemblage and the use of plants during site occupation (Schiffer 1987).

6.1.2 Formation Processes of GUS Archaeobotanical Assemblage

The formation processes responsible for the archaeobotanical assemblage at the time of site occupation (Figure 37, first box) are specific to individual cultures and the site's placement in the landscape. Plant remains are either added (input) to a site accidentally or intentionally. These plants may serve a wide variety of uses and therefore will be deposited within different site features depending upon their use. Re-deposition of plant material in an archaeological site is a dynamic situation (Figure 38) resulting in most archaeobotanical samples consisting of plant material of different ecological origins but deposited in one feature (Behre and Jacomet 1991).

The formation processes depicted in Figure 38 all potentially relate to the GUS site. The plant remains found at the GUS site were likely deposited there by a combination of natural processes (e.g., seed bank, wind and animals) and cultural processes (e.g., collecting or harvesting plant material as fodder, food, medicine and raw material).

For all of Greenland, 13 plant communities have been described and about 500 plant species collected and identified (Böcher *et al.* 1968) with no successful cultigens. Although the Greenlandic flora is limited in diversity compared to other regions of the world, the Greenlandic vegetation represents one of the most important resources the Norse and their livestock exploited. It was the vegetation that first attracted the settlers and resulted in the name "Greenland", implying a 'wealth of vegetation'. The Norse built

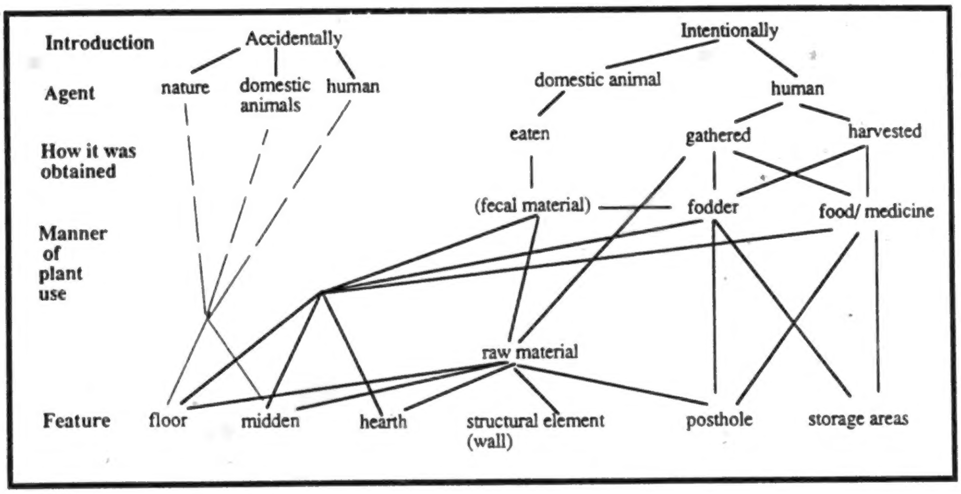

Introduction
Agent
How it was obtained
Manner of plant use
Feature
Accidentally
nature
domestic animals
human
Intentionally
domestic animal
human
eaten
gathered
harvested
(fecal material)
fodder
food/ medicine
raw material
floor
midden
hearth
structural element (wall)
posthole
storage areas

Figure 38. Processes of introduction and uses of botanical material in a Norse Greenlandic site (Arneborg 1991a ; Clapham and Scaife 1988; Dennell 1976; Hally 1981; Lennstrom and Hastof 1995; McGovern 1993b; Miksicek 1987; Schiffer 1987).

their homes from turf; roofed their buildings with twigs, turf and other plant resources; filled their mattresses and pillows with moss and peat; used woody vegetation as well as the manure of grazing animals for fuel; insulated their floors with mats of vegetation; and relied on the Greenlandic flora to nourish their animals and to a limited extent themselves by collecting berries (Figure 39) (Buckland *et al.* 1983; Fredskild and Humle 1991; Roussell 1936). Only 34 of the plant taxa found in Greenland were identified by macrobotanical remains from GUS. A total of 70 taxa have been identified by all workers form Norse archaeological sites (Appendix 2). It is difficult to determine if an occurrence of a specific plant remain in a feature (Figure 38) is the result of direct use, indirect use or just an accidental occurrence due to the limited number of

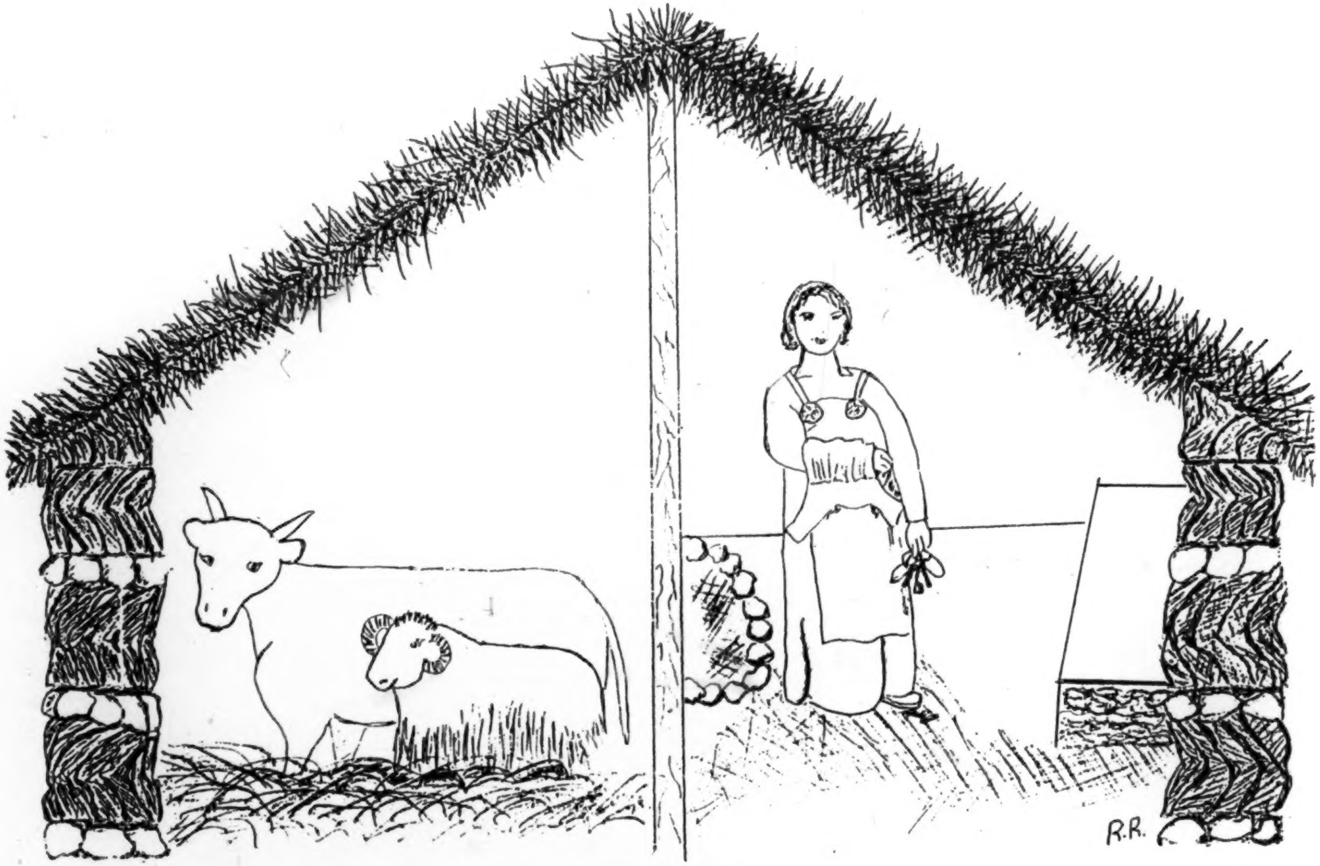


Figure 39. Stylized drawing illustrating the generalized plant use of Norse in Greenland. Drawn by R.Ross

species available and apparently exploited. The heavy reliance on a limited flora results in uncertainty when trying to interpret a specific plant use within different features.

6.1.3 Problems with Paleoethnobotanical Records

It is assumed that archaeobotanical assemblages will always be altered by formation processes and will never come to us unchanged and complete. This is a fact that all researchers realize and attempt to accommodate through their methods and theoretical approaches. Formation of the paleoethnobotanical record and the problems inherent with it were explored extensively during the 1970s and 1980s by many researchers (Begler and Keatinge 1979; Botteman 1984; Dennell 1976; Green 1982; Hally 1981; Miksicek 1987; Minnis 1981; Munson *et al.* 1971; Schiffer 1987; and Van Der Veen 1984). Problems inherent in the paleoethnobotanical record may include: (1) plant remains that represent "noise" defined here as plant remains that are natural deposits or the result of indirect uses (Figure 37, first and second boxes); (2) contamination by post occupation seed remains (Figure 37, second third and fourth boxes); (3) mixing of remains between stratigraphic or excavated layers (Figure 37, first and second boxes); and (4) biasing of the archaeobotanical record due to the loss of plant remains (Figure 37, all boxes).

The paleoethnobotanists who have explored these problems have drawn on their own site specific experiences to establish basic guidelines that provide caveats to interpretations. I have assembled these basic guidelines and summarized them in Appendix 7. For the most part, paleoethnobotanists have worked on botanical material from archaeological sites where an agricultural economy was practiced and the paleoethnobotanical remains were carbonized. Minnis (1981) offers a reason for the focus on carbonized remains. "By considering charred seeds as prehistoric and uncharred as modern, unless there is a reason to believe otherwise some prehistoric patterns *may* be lost. However to do other wise will *definitely* increase the "noise" in the archaeological seed assemblage due to the potentially large number of seeds found naturally in soils" (Minnis 1981:147). Reliance on carbonized seeds has been reinforced by other researchers (Lennstrom and Hastof 1995; Miksicek 1987). Formation processes operating at agricultural sites will differ from processes operating at sites where other subsistence strategies such as pastoralism or gathering were practiced. While insightful, the guidelines formulated in the 1970s and 1980s are of limited use to paleoethnobotanist working on assemblages resulting from different subsistence activities and exhibiting different types of preservation. When non-carbonized materials are excavated there is no convenient way to determine which seeds are related to anthropogenic activity. Minnis (1981:143) simply states that "water-logged sites ...., will present different problems for the paleoethnobotanist". The different problems to which he alludes are all of those which he considers eliminated if one "only interpret(s) carbonized macrofossils". Carbonized macrofossils are assumed to ensure that the remains identified and interpreted are both anthropogenic and were present at the time of site occupation. This assumption does not applied to waterlogged contexts, leaving researchers in these contexts with all of the problems of interpreting a archaeobotanical assemblage (e.g., uncertain pathways, contamination, mixing, "noise") without the assumed advantage provided by carbonized remains.

6.1.3 Waterlogged Sites

Although the problems of interpreting a waterlogged assemblage are great, waterlogged sites also have many benefits. More questions about plant use can be dealt with as data are often not as limited. Waterlogged archaeological sites offer a wealth of information due to the excellent organic preservation which often results in a great number of taxa being found in a greater variety of features compared to assemblages resulting from other means of preservation such as carbonization (Wilson 1984). Since waterlogged remains are not dependent on exposure to fire to ensure their survival, a wider variety of plant material with less bias toward those that come into contact with fire will be recovered. Contact with fire is often, but possibly incorrectly assumed to be, the result of cultural activity.

Waterlogged sites represent the smallest proportion of sites examined for botanical remains (Miksicek 1987). Some of the reasons for this statistic may be: the research strategies applied to waterlogged sites; the logistics involved with macrofossil examination; a lack of understanding of the formation processes involved in the archaeobotanical assemblages; the fact that very few cultures live in areas where waterlogging of sites was likely to have occurred; and the cost associated with excavating a waterlogged site may be some of the reasons for this statistic. Waterlogging can be defined as "preservation of uncarbonized remains in cool dark, anaerobic conditions" (Robinson and Mikkelsen 1993:14) where water is present all or part of the time (Coles 1984). The abundance of well preserved material which is not dependent on a cultural activity such as fire amplifies the problems of how to identify plant remains which are the result of human activity and those which constitute "noise". The problems of interpreting a waterlogged site can be minimized if formation processes, taphonomic factors and sampling strategies are all carefully considered. Only careful examination in the field and laboratory, as well as specific sampling strategies, can establish formation processes operating on an assemblage.

Conditions for preservation at waterlogged sites can be modified by alternating wet and dry condition, and/or soil chemistry (Ruppé 1988). Soil and microbiological conditions should be monitored so that the damage to the remains can be assessed and the possibility of differential preservation within a site can be addressed. Detailed field and laboratory analyses, such as geochemistry and microbiological activity should be undertaken (Hally 1981; Green 1982). Unfortunately, little experimental work on preservation of botanical remains under waterlogged archaeological conditions have been done, probably because of the length of time required to complete an experiment and the numerous biological factors that are difficult to control. With some experimentation it might be possible to rank macrofossils in order to establish if there are any which are more susceptible to decay. Fragile macrofossils could then serve as indicators of the preservation environment. Hardwoods, for example, have been ranked on a scale from very resistant to slightly resistant to decay (Schiffer 1987: Table 7.1). One may assume that if a delicate macrofossil occurred in a number of samples these samples are preserved to about the same degree. This does not indicate that preservation is the same throughout the entire site, nor does it account for the cultural transformations that may be responsible for the presence or absence of a plant species.

The size, shape and discoloration of waterlogged botanical remains as well as any gnaw marks may assist a researcher in determining if macrofossils are *in situ* or introduced (Minnis 1981). Differentially preserved and particularly "fresh" material should be excluded from any interpretations. Burial conditions at the site should also be considered. Modern contaminants are more likely the case with shallow site provenience. As a general rule, the modern seed content in sediments diminishes significantly between 20 and 100 cm in depth, although time and depth do not have a linear relationship (Minnis 1981). Consideration must also be given to the time it took for a site to be buried out of the reach of modern contaminants. Attention must be given to post-depositional disturbances (e.g., bioturbation, cryoturbation, argilliturbation, or destructive human activities) to avoid sampling mixed or contaminated sediments (Schiffer 1987).

6.1.5 Identification of Formation Processes at GUS

The overall preservation within the GUS site is uniformly high. Leaf buds, Betulaceae fruits and wood, all relatively delicate macrobotanical remains (Dimbleby 1978; Schiffer 1987; Wilson 1984) and are consistently found in the samples examined. This indicates excellent preservation attributable to the fact that the site was sealed with sandy alluvium and then frozen into the permafrost. It is very unlikely that the GUS archaeobotanical assemblage has been contaminated by modern botanical remains as all the plant fragments recovered exhibited a similar degree of degradation and none appeared "fresh". Once GUS was buried and then frozen, the archaeobotanical assemblage was sealed and no longer susceptible to post-deposition disturbances (e.g., bioturbation, cryoturbation, argilliturbation or destructive human activities). The low temperatures and high water (frozen) content also reduces oxidization, humification and microorganism decay. There was a period of time when post-depositional processes altered GUS; the length of time between site abandonment and burial is not exactly known (Figure 40) (Schiffer 1987, Schweger in press).

For GUS only the cultural and natural transformations operating between the time of occupation and burial must be considered. There are five general formation processes that could have resulted in the addition (input) or loss (output) of botanical remains. (1) Reuse of an abandoned Norse structure by Thule-Inuit. The Thule-Inuit could have deposited plant material they collected in Norse features or if the reuse of the site involved any building or digging plant material may have been either removed or redeposited. (2) The inevitable disintegration of the roof and walls would introduce material into secondary contexts (Arneborg 1991a; McGovern

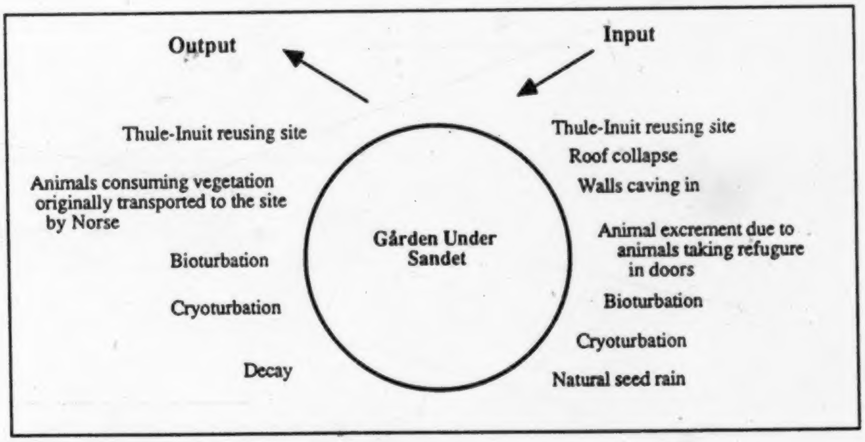

Output
Input
Thule-Inuit reusing site
Animals consuming vegetation originally transported to the site by Norse
Bioturbation
Cryoturbation
Decay
Gården Under Sandet
Thule-Inuit reusing site
Roof collapse
Walls caving in
Animal excrement due to animals taking refugure in doors
Bioturbation
Cryoturbation
Natural seed rain

Figure 40. Formation processes operating at GUS post-abandonment-pre burial of site.

1993b). (3) Animals, either wild or abandoned domestic that might have sought shelter within a Norse structure and contributed (input) botanical material in the way of manure or removed (output) plant material though consumption. (4) Natural transformation such as bioturbation and cryoturbation might have resulted in the mixing of botanicals between levels or destruction of delicate remains. (5) Plants growing on site after abandonment would also have contributed a significant number of seeds while the natural decay process would have removed seeds from the site.

6.1.6 Archaeobotanical Sampling Strategies

It is not unusual on waterlogged sites for plant material to make up 95% of the archaeological sediment (Bocquet *et al.* 1987). The quantity of identifiable botanical remains from these deposits are often immense (Robinson *et al.* 1991) and can become burdensome during analysis. Careful field and laboratory techniques will aid recognition of most formation processes. Unlike most archaeological sites, interpretations based on waterlogged sites need not be concerned by what data are absent from the record, but with how to delineate patterns of human plant use from the "noise" provided by the material not so employed. The separation of cultural patterns from "noise" is a problem in all archaeological contexts but this distinction becomes even more difficult if a culture relied heavily on plants for construction material and if the site is waterlogged (Figure 39). From the literature four different strategies to eliminate "noise" can be distinguished (Table 4).

Sampling Strategies	Benefits	Limitations
1) Only consider botanical remains known to be used in the time and areas being studied	• "noise" is eliminated	• little new interpretation could be made • most of the assemblage would be considered "noise"
2) Only collect samples considered to be type one	• specific information could be obtained with little "noise" • financial and time requirements would be limited	• biases record • If any "noise" is present it may not be identified because of a lack of control samples
3) Analyze everything	• could determine both cultural and non-cultural patterns • potentially a lot of new information discovered	• extremely time and financially consuming
4) Collect control samples from "noncultural deposits" and uncultivated areas	• "noise" should be eliminated • provide new information about natural seed occurrences	• very time and financially consuming • the choice of control samples may skew data • unaffected areas difficult to access because of the burial of site
5) Strategy Five Combination of strategies 1-4	• type one samples would establish cultural pattern • control samples would provide new information about natural seed occurrences • interpretations of type two and three samples could use patterns from type one and control samples and not be limited to just previously known plant use patterns	• very time and financially consuming • the choice of control samples may skew data

Table 4. Benefits and limitation of five research sampling strategies to eliminate "noise".

Jørgensen (1986) and Robinson (1987, 1996; Robinson *et al.* 1991) eliminate "noise" through implicit and explicit procedures. The implicit procedure places emphasis on discovery of known, culturally used, botanical remains (e.g., cereals, monastery plants, collected edible plants, weeds of cultivated fields, and those plants found in ritual contexts) (Jørgensen 1986; Robinson 1984, 1987; Robinson *et al.* 1991). Plants from more general contexts or those used indirectly as raw material are listed and possible usage suggested. In this way, they minimize the potential "noise" and concentrate their efforts on botanical material that is assuredly the result of direct human use. Their explicit procedure is to sample only those features with well defined cultural functions. The quality of information obtained from various features can be ranked from best to poorest. Robinson (1996) divided potential features to be sampled from an urban context into three types. The first type included remains such as human or animal excrement found in contexts with well defined functions and where the fecal material was likely first deposited, such as a latrine or a byre. Such contexts demonstrate plant consumption, be it local resources or imported food. The second type included remains identified as type one but discovered in a secondary context, such as feces in a midden. Floor layers can also be included as second type samples, as the deposit includes botanical remains from many, diverse primary contexts. The third type included deposits such as middens, multi-use pits and fill layers in which the materials deposited over time were from multiple sources with uncertain primary contexts.

To provide an example, consider the different interpretations placed on an exotic such as a grape seed (*Vitis* sp.) found in Greenland. If the seed were found in human fecal material within a latrine, trade likely occurred and the grapes were consumed and not made into wine. The same interpretation may be made if the grape seed was found in fecal material deposited in a midden, but how the seed relates stratigraphicaly and chronologically to other botanical remains and artifacts may be difficult to establish. If the grape seed was found in midden matrix, it is only known that the grapes were introduced into the midden at some point during the time the midden was used. Its presence could be due to human activity or some form of turbation.

Lennstrom and Hastof (1995) suggest a third way of eliminating "noise" which is nearly opposite to those of Robinson (1996). They suggested that if all features are not sampled there is no way of 'knowing' if any patterns that might be discovered are of human origin or the result of natural transformations. The use of control samples, a slight variation of strategy three, is a fourth way of eliminating "noise". Comparisons between control samples and samples thought to contain a human pattern may be useful in determining what is a natural assemblage and what contains cultural information (Minnis 1981; Green 1982; Miller and Gleason 1994; Lennstrom and Hastof 1995). Where these control samples are to be collected is not often explicitly stated. Lennstrom and Hastof (1995) suggest obtaining control through sampling all site matrix, while Miller and Gleason (1994) recommend that control samples must be taken from outside cultivated areas. However, cultural landscape studies clearly demonstrate that human activities widely impact the landscape and are not just limited to agricultural fields (Cynthia Zutter, Grant MaEwan College, personal communication 1997). High levels of variability can exist in control samples; for example, Van Der Valk and Davis (1979) found a range of taxa (8 to 20) and numbers of seeds in seed banks of a localized area suggesting that off-site control samples may not be as useful as some paleoethnobotanists might hope. The extent of the human impact can be demonstrated by an example from the Tehuacan Valley, Mexico. Irrigation systems can extensively change an arid region, not only through the irrigation of cultivated areas but also through the destruction of natural drainage patterns (Smith 1967). Where a control sample should be taken from in this situation my be difficult to determine.

A fifth strategy (Table 4) proposed here would combine elements of the first four, depending on the research question, the time available, fiscal constraints and the nature of the site. Type one samples (Robinson 1996) should always be collected, but to restrict a research strategy to these samples would result in a limited record. Collecting some type two and three samples (Robinson 1996) should also be done. Although these may contain a lot of "noise", there is still information to be obtained from them and this practice approaches the Lennstrom and Hastof (1995) 'sample everything' strategy. Off site control samples should also be taken as it is from these that the natural "noise" found in type two and three samples may be identified. Type one samples can also serve as control samples by identifying cultural patterns from the "noise". For example, a sample of stored hay represents a cultural deposit. Plant remains from a sample of this deposit can be "subtracted" from a byre floor sample in order to determine what portion of the floor sample is the result of fodder and which is not.

Strategy Five is by far the best approach for a site such as GUS. The control samples allow for the recognition of "noise" and the type one samples provide a basis for more specific interpretations of botanical remains from a limited variety of features with known functions. This strategy could potentially be used to confirm the presence of specific formation processes involved with the development of type two and three samples. While Strategy Five requires a considerable amount of time it would still require fewer resources in terms of time and money than strategy three or four.

In conclusion, it is apparent that formation processes involved in the creation of an archaeobotanical assemblage are complex. Archaeobotanical assemblages which are the result of waterlogging, freezing and desiccation or from the activities of pastoralists, or hunter-gatherers represent a sizable number of sites throughout the world. However, published literature concentrates on only a select type of formation processes and sites, those with carbonized material from settled agricultural communities. More attention should be paid to formation processes involved in the creation of non-agricultural sites displaying a variety of preservation types. In this way different, yet complementary, data sets are generated. There are four main problems in most paleoethnobotanical assemblages: (1) plant remains that represent "noise" defined here as plant remains that are natural deposits or the result of indirect uses; (2) contamination by post occupation seed remains; (3) mixing of remains between stratigraphic or excavated layers and; (4) biasing of the paleoethnobotanical record due to the loss of plant remains. The main disadvantage to waterlogged sites is that the "noise" present in an assemblage is likely greater than on many other sites. The "noise" can only be eliminated by the use of Strategy Five.

6.2.0 Discussion

Complete excavation of the GUS site and the careful attention paid to building phases (Figure 17) means that many of the archaeobotanical samples may be relatively dated. This enables one to investigate diachronic phenomena and changes, such as vegetation response to climate change or shifts in cultural land-use practices. Room 27, the long house, was the first structure established at GUS; constructed in the 1100s it was used for roughly fifty years (Jette Arneborg, personal communication 1997). The other rooms were constructed in different phases but for ordering samples are placed in chronological order based on the last phase of their occupation (Table 2). A room might have been built in the first phase and used until the last phase but, because of cleaning episodes and redeposition of material on middens or the infield, multi-layered floors are associated with the last building phase. The following discussion of the paleoethnobotany will follow the order presented in Chapter 5 except that the macroremains and pollen will be discussed together. My interpretation of the plant remains relies heavily on the ethnobotanical research done by others around the North Atlantic (Appendix 8). The last section of this chapter demonstrates the usefulness of sampling Strategy Five, employing all type one samples and the byre floor samples which are considered to be type two samples. Throughout the discussion specific formation processes are identified, as are any situations where interpretation could have been improved by the implementation of sampling Strategy Five (from here on referred to as Strategy Five).

6.2.1. Long House

The long house is believed to be the oldest Viking house type found in Greenland. The structure of the Greenlandic long house was presumably derived from a Norwegian type with the Icelandic modification that large domestic animals were not housed in the structure (Gad 1970). Long house structures might be more correctly associated with *Landnám* or first settlement of an area rather than a specific early time period. The GUS long house is the first long house structure in Greenland to be completely excavated. While other long houses have been found in the Eastern and Western Settlements, early archaeological techniques and a resistance to excavate resulted in very few complete excavations having been made (Jansen 1972). The archaeobotanical samples that were examined from the long house include floor layers, a construction layer, a hearth, a cooking area and a "grass" sample. These are the only archaeobotanical samples taken from a Greenlandic long house and provide the first opportunity to examine what plants may have been associated with the early stages of farm development.

Sample 3167 (Figure 19) was designated in the field as the "first long house floor layer" and overlies sample 3160 (Figure 22), the long house construction layer. The two paleoethnobotanical assemblages are similar, conceivably the result of mixing between the two layers once construction was finished and people began walking on the wood chips this is an example of a cultural transformation. There is a gradual accumulation of anthropogenic deposits as macrobotanical concentration increased from 122.4/100 ml for the construction layer to 350.7/100 ml for the first floor layer. Berry seeds from *Empetrum nigrum* and *Vaccinium vitis-idaea* are probably evidence of intentional transportation of plants into the house for human consumption (Fredskild and Humle 1991). The other long house floor samples (3039, 2823, 2830), from oldest to youngest based on depth, suggest floor covering alternated between Heath/Outfield and Wetland groups (Figure 41).

The construction layer contained wood chips, likely from shaping drift wood for supporting and roof beams. Sample 3160 (Figure 22) from this layer is dominated by plant remains from the Heathland/Outfield group, mostly in the form of leaf buds. Although drift wood was used for major construction needs, local birch and willow may have also been used. Further identification of the leaf buds might indicate a preference for Betulaceae or Salicaceae as building material. Alternatively, these plant remains might also represent

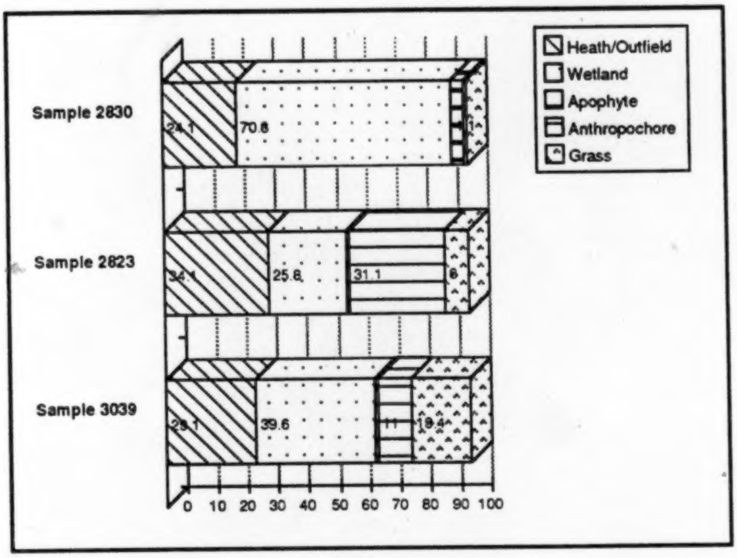


Figure 41. Alteration between the domination of macroremains from Wetland and Heath/Outfields Groups in floor layer.

the remains of floor covering. Here is a situation where sampling according to Strategy Five would have aided in establishing more specific interpretations. If samples had been taken from roof and wall structural elements the specific meaning of leaf bud concentrations might be determinable.

It has been suggested that the Norse used sheep pellets and bone for fuel (Albrethsen and Keller 1986; Gad 1970; Nørlund 1936); however the following samples suggest other fuel sources were also being used. Sample 3216 (Figure 19) from the central hearth is dominated by leaf buds and *Betula* scales and seeds, botanical remains indicating the use of Heathland/Outfield wood. Other macrobotanical remains could have been introduced as kindling or through burned fecal pellets. The cooking pit (sample 2727 Figure 19), in contrast, is dominated by wetland species (73.5 relative percent); this is probably either the result of burning peat or dung derived from these sources. As these two samples are contemporaneous, they suggest that different fuels may have been used depending on the purpose of the fire (Dimbleby 1978). Burning dung produces a slow burning, hot, long lasting and even heat as opposed to grass which produces a fast but much hotter flame (Arnold 1958, Rye 1981). How this compares to different wood types is not known. Sampling of hearths for all Norse Greenlandic sites might lead to recognition of patterns of fuel use. Added to a comparative data base, these samples would assist in the implementation of Strategy Five.

The "grass" sample (3264) might represent fodder collected by the farmers at GUS. The macrobotanical remains in this sample contain an even split of Wetland and Grass groups, the ideal fodder for Icelandic sheep (Zutter 1996). Still, this sample could also represent stored grass for burning, stuffing or even flooring.

Compared to all the GUS samples analyzed the long house samples contained the smallest number of anthropochores (8-72.1) and apophytes (1-2.1). From this one may infer that the Norse had inflicted minimal disturbance to the landscape with settlement and during the time the long house was inhabited. Fodder would have been collected from productive wetlands and grasslands and the near absence of weed-like plants favored by human activity suggests the Norse activity had a minimal consequence on the vegetation at this point. However, the presence of *Capsella bursa-pastoris* an imported anthropochore, suggests that plants dependent on human activity were present. We know from later samples that anthropochores rapidly establish themselves and became prolific, possibly dominating the infields. *Capsella bursa-pastoris* has been found at five other Norse sites (Appendix 2).

6.2.2. Living Rooms

Room 6 was constructed and used only during the fourth building phase. Sample 2602 (Figure 24) contains very few macrobotanical remains and these are dominated by *Carex* taxa that likely represent floor covering (Fredskild and Humle 1991). Room 4 has gone through multiple building and use phases. It was first constructed in building phase four and subsequently divided into rooms 4a and 4b during building phase five. During the sixth building phase Room 4b was sealed off and only Room 4a was used to byre sheep. The floor layer of the fourth phase (sample 2484) is dominated by anthropochores and grasses (Figure 24) that probably represents floor covering (Fredskild and Humle 1991). This differs from twig flooring found in other sites (e.g., Sandnes) (Fredskild and Humle 1991). *Empetrum nigrum* and *Vaccinium vitis-idaea* seeds are relatively abundant in this sample. Seed concentrations of these berry-producing taxa are usually associated with deposits of human excrement indicating their role in the diet, although twigs with attached berries may have been used for different purposes (Buckland *et al.* 1983; Fredskild and Humle 1991). Berries may have been accidentally dropped and lost in the grass and sedge floor matting or represent someone spitting out the seeds. These interpretations are not wholly satisfactory as Room 4 is designated as living space and there was no indication that it might have been used as a latrine. However, fragments of wool textiles were found in the room (Arneborg 1996b) might lend support to its use as a latrine, as wool has been used as toilet paper and for feminine hygiene (Greig 1981).

Sample 2266 from the floor of Room 4b is dominated by the Anthropochore group, specifically *Capsella bursa-pastoris* (Figure 25). It was probably included in vegetation collected locally to be used as flooring, although it may have served specific cultural uses as a diuretic or for medicinal purposes (Usher 1974) (Appendix 8). *Polygonum viviparum* was also recovered from this room in its greatest numbers for any sample. Fredskild (1973) used its presence to indicate a drier climate but this could simply be the result of plant collection from dry lands. The root of *Polygonum viviparum* is recorded as a vegetable used by Inuit groups (Usher 1974), but there is no precedent for this use by the Norse. Sample 2283 from Room 4a is either contemporaneous with sample 2266 from Room 4b or younger. Again, anthropochores dominate (Figure 26) this sample, probably representing floor covering. The consistent domination of weed species in flooring material suggests that the Norse recognized the potential use of these plants as flooring or that floor covering was at least in part collected from the infield which had become infested with weedy species. However, the abundance of *Capsella bursa-pastoris* may only be a result of its proximity to the site and its prolific production of seeds rather than to a specific cultural preference for this plant.

Sample 2267 from Room 1, designated the weaving room because of the number of loom weights and loom parts still wrapped with wool (Arneborg and Berglund 1993), is also dominated by Anthropochores followed by the Wetland group (Figure 26). This suggests a further use of weeds as flooring.

A floor layer (2624) (Figure 27) and posthole deposit (2604) (Figure 28) from Room 19, which has not yet been assigned to a building phase were analyzed. The floor sample collected near a fireplace contained animal hair, droppings and twigs. Although twigs were readably observable, few leaf buds were found suggesting that the twigs were collected in the summer after the leaves had emerged. The field evidence for the presence of animals in this room and also a fireplace make the interpretation of the macrobotanical remains troublesome. It is unclear why a hearth would have been placed in the same room as domestic animals. Room 19 might have been a sheep shearing room, a warm place for sheep to drop their lambs, or space shared by animals and people. The last suggestion is supported by the number of *Vaccinium vitis-idaea* seeds which may have been eaten by people, attached to twigs that served some purpose, or accidentally dropped on the ground. *Polygonum convolvulus* is also found in Room 19. While many *Polygonum* taxa are identified as ingredients used to make gruel (Usher 1974), *Polygonum convolvulus* has not been included. For now, it is only indicative of an introduced anthropochore. This is the first record of *Hippuris vulgaris* in a Norse Greenlandic site its occurrence in any quantity is of interest. Its presence could be accidental, included in animal droppings or brought in with pails of water, or it indicates the use of wetland species collected around ponds (Bent Fredskild and David Robinson, Natural Sciences Unit, Danish National Museum, personal communication 1995) or was deposited on the infield as a result of irrigation (Baymen *et al.* 1997).

Posthole features are often considered gold mines to the paleoethnobotanist as the depression provides an ideal place for seeds to become trapped during cleaning episodes and are also places which are protected from intense burning when catastrophic fires occur. Postholes in many archaeological sites have proven to be rich locations for archaeobotanical remains. As GUS is a waterlogged site the, posthole from

Room 19 contain macroremains that are the result of cultural transformation processes such as episodes of room use or cleaning (Van Dan Visteren 1984). The plant groups found in sample 2604 are evenly distributed between groups indicating that generalized plant use occurred in this room.

6.2.3. Animal Rooms

In sample 2450 from Room 7, while all plant groups were represented, the Anthropochore group dominates. The anthropochores were likely included as bedding or possibly a type of fodder. If they represent fodder the likely source was probably the infield (*tun*). The presence of ***Hippuris vulgaris*** suggests that drinking water was stored for livestock. The seed assemblage from sample 2450 was most similar to that of 2624 in Room 19 (Figure 27). This implies a similar source for the floor covering. Alternately, similar seed assemblages may be due to similar cultural transformations for the rooms. It is reasonable to suggest that rooms used to house sheep would result in more similar seed assemblages compared to those produced in a living room. If this is so then Room 19 may have housed sheep, and not people. Sampling structures that clearly served as sheep shelters would help answer this question and would be an example of how Strategy Five could be of further use.

The pollen samples (Figure 34) from Room 3, the byre, were all dominated by plants from the Heath/Outfield group, especially ***Betula nana***, although sample 2465 contained an equal number of pollen grains from ***Salix*** sp. taxa and ***Betula nana***. Using Rasmussen's (1993) work as a basis, these remains possibly represent both fodder and floor covering. All of the samples

(Figure 30) investigated for macroremains contained some *Vaccinium vitis-idaea* which may indicate, as suggested by Roussell (1941), that servants were living in the byre or the byre was used for depositing waste including human fecal material. Room 3 samples 2470, 2424 and 2425 contain abundant amounts of *Montia fontana*, a plant favored by human inhabitation and common in botanical samples taken from other Norse sites (Fredskild 1973). *Montia fontana* thrives in manured areas and under moist conditions (Fredskild 1973, 1989). It possibly grew *in situ* (Fredskild and Humle 1991) in the byre during the summer if a door or roof was missing, or was brought in from the infield. The presence of *Polygonum viviparum* possibly indicates the exploitation of a dry vegetation community for fodder as mentioned earlier but can indicate a drier climate (Fredskild 1973). *Polygonum viviparum* and *Montia fontana* found together in byre samples make any climate signal unclear. *Rhinanthus* sp. seeds are found in large quantities in sample 2425 from what is believed to be a feeding trough. The presence of *Rhinanthus* sp. suggests a meadow source for hay that was collected and returned to the byre for storage or use (Greig 1984). Anthropochores contribute between 35 and 77% of the plant macro remains in the byre samples while grass represents 8 to 43%. The byre samples roughly correspond in composition to the preferred diet of modern Icelandic cows. Modern Icelandic byre and manure samples indicate that cattle ingest significant amounts of apophyte, anthropochore (60%) and Gramineae (30%) dominated vegetation (Zutter 1996). The feeding trough sample (2425) shows no significant difference from the samples collected from the middle of the byre. The relative consistency of plant macroremains throughout the byre suggests that plant material was homogeneously spread through the byre, that mixing due to use of the byre eliminated any patterns of intentional plant deposition, or the plant material used as fodder and bedding were all from the same source area. Roussell (1941) points out that various shrubs were used as bedding and food in the byre, the relatively few leaf buds found in the GUS byre samples indicate that shrubs were collected in the summer.

6.2.4. Manure

Pollen content of modern caprine fecal material has been shown to reflect the animals' diet and not the surrounding vegetation (Moe 1983; Rasmussen 1993). At GUS the caprine diet, based on pollen results, was predominately *Betula nana*, *Salix* sp., and *Alnus crispa* (Figure 31 and 35). Although *Alnus crispa* occurs in the GUS area today it is found with a much reduced stature in small stands in protected areas. *Alnus* -rich fodder was either collected from considerable distances where *Alnus* growth was more prolific or the presence of *Alnus* at GUS is the result of *Alnus* abundant pollen production and dispersal which could accumulation on other plant material being ingested. The similarity of pollen composition from the manure samples indicates that the caprines were being fed (Moe 1983) twig or leaf fodder and were not free-ranging. Free-ranging animals might have been penned at night (Albrethsen and Keller 1986).

In contrast, manure pollen samples JR9.96 and 2586 do not show a dominance of Betulaceae and Salicaceae. Sample JR9.96 contains roughly equal amounts of Heath/Outfield and Grass groups while grass pollen dominates sample 2586. Due to a greater diversity in pollen taxa, samples 2586 and JR9.96 may indicate a more diverse diet, possibly the result of free ranging activity.

The macrobotanical remains recovered from manure samples indicate a very different picture of fodder composition from that recorded by pollen. While the Heath/Outfield group dominates the pollen assemblage, the macroremains are dominated by Cyperaceae remains. It is possible that the delicate seeds of Betulaceae and Salicaceae would not survive the passage through a caprine's alimentary canal. In general, the complementary data of pollen and macroremains indicate that the Norse caprines in Greenland were surviving mostly on woody shrubs and wetland plants.

No uniform diet is evident from the cow dung samples (Figure 32 and 38). Sample 2456 only contained three fragmentary pieces of Gramineae seeds. The rest of the sample was an amorphous dark organic material. Experimental studies have shown that whole wheat grains pass through a cow's digestive tract intact (Robinson and Rasmussen 1989). If all Gramineae can be assumed to have similar resistance to a cow's digestive processes, the fragmented Gramineae found in 2456 may indicate that the grain was processed by pounding or soaking to aid digestion before being fed to the animals (Robinson and Rasmussen 1989). Samples JR20.96, 3454, Sch8.7.96.4 and Sch10.7.96.2 indicate two different sources of fodder. Sample JR20.96, is dominated by plants in the Heath/Outfield group and contains a variety of other taxa representing numerous plant groups. Samples 3454, Sch8.7.96.4 and Sch10.7.96.2 are dominated by grasses followed in all cases by plants in the Heathland/Outfield group. Based on Icelandic research the ideal diet for Greenlandic cattle would have been dominated by grasses and weed species (Zutter 1996). At GUS the dominance of grasses in the diet of cows argues against theories that a deteriorating climate resulted in poor fodder quality and eventual abandonment. At least in these samples, cows apparently had access to their preferred foods. It is curious that weed species are not better represented in the pollen assemblage since they were available as indicated by other samples. The absences of pollen from weedy taxa may be due to the specific time these plants were in bloom. Clearly, more analysis needs to be done from chronologically controlled type one samples before definitive statements can only be made concerning diet and changes in fodder quality.

6.2.5. Construction Material

The Norse were dependent upon vegetation for the construction of their structures and no doubt directly impacted local plant communities, therefore, indirectly altering their farming system. In the opposite way any change in plant cover, whether the result of climate change or grazing, would have influenced the Norse's ability to house themselves. Although changes in vegetation through time would directly alter construction, sampling construction material is unlikely to be informative about these changes. In most cases it would be impossible to associate construction material with a specific building phase as cultural transformations are always resulting in the recycling of material.

Samples 2618, 2343 (peat blocks), 2319 (turf block) and 2334 (manure fill layer) are all considered to be construction material (Figure 33). Analysis of construction material reveals what plant communities were exploited and how building material will contribute to the archaeobotanical assemblages present in all structures. Sample 2618 was originally designated on the basis of its preserved roots as a surface peat and was considered to be taken from the *landnám* surface (Guðmunder Ólafsson, Icelandic National Museum, personal communication 1995). This sample had mostly moss and root fragments, and only 37 macrobotanical remains making it difficult to draw conclusions about the specific sources of the peat block. In all likelihood, it does not represent the *landnám* surface, because *Capsella bursa-pastoris*, a plant introduced by the Norse, is present. Sample 2343 from a wall in Room 5 is also considered to be representative of a *landnám* peat block; it also has a low macrobotanical total (71) and was dominated by plants from the Heathland/Outfield group. It is surprising that any other groups are present; it seems logical that the seeds found in a single peat block would represent only the plants that grew on the peat surface. Some of the macrobotanical remains may be the result of contamination from other construction material within the wall. The relatively low total counts for both peat block samples suggests that on an individual basis a peat block, a type one sample, would input a limited number of botanical remains to a type two sample such as a floor.

The turf block 2319 had a much higher macrobotanical count (641) and was dominated by anthropochores. This indicates either that the turf is from a post *landnám* period when weeds dominated or that the area it was collected from was favorable for anthropochores. The number of *Daphnia ephippia* brood pouches indicate that an aquatic environment contributed to the sample assemblage.

As expected the macrofossil composition for sample 2334, a manure/midden wall fill layer (Figure 32) was similar to that of the sheep stable or cow byres. In fact, the composition of sample 2334 is very similar to the pie diagrams from floor layer samples from Rooms 7 and 19. Plants from the Outfield, Wetland and Anthropochore groupings are found in relative equal amounts. The occurrence of *Hippuris vulgaris* suggests, as noted before, multiple cultural transformations. The presence of a layer of manure/midden material within the walls of a structure could indicate a shortage of labour or land from which to obtain peat and turf. Midden fill layers may even be the result of the Norse recognizing that they could not continue to strip the land surface of vegetation without seriously inhibiting their ability to feed their livestock. The use of midden fill in the buildings may be an adaptive attempt, although a smelly one, to limit the damage caused to the landscape by house building. However it likely represents typical Norse building practices as similar fill layers are found in Iceland (Guðmunder Ólafsson, personal communication 1997). This sample demonstrates yet another cultural transformation, the reuse of botanical material within a site whereby older material is recycled and contaminates younger deposits.

6.2.6 Demonstration Strategy Five

Strategy Five (section 6.1.6, Table 4) has been developed as a solution for separating what is considered "noise" from what may be cultural patterns. The use of type one samples from this strategy should assist in making more specific interpretations of type two and three samples. To implement Strategy Five, control, type one and type two or three samples should be analyzed. The use of control samples will indicate what plant remains in type two and three samples can be considered noise and the analysis of type one samples will assist in interpreting the specific formation processes involved in the formation of a archaeobotanical assemblage of type two or three samples.

To demonstrate Strategy Five, I will rely on type two samples from the GUS byre and all type one samples analyzed. It is my hypothesis that the composition of type two samples (the byre floor) should be a composite of related type one samples. Paleoethnobotanical remains not accounted for in this way become "noise" and/or are the result of indeterminable origins. Only a preliminary demonstration of Strategy Five can be done as the samples at GUS were not taken with this objective in mind. It is unfortunate that no roof samples from the GUS site were analyzed as these would also contribute to the botanical material found in the Norse floor layers (McGovern 1993b). The first step is to identify the sources of botanical remains and the formation processes that resulted in the addition (input) and loss (output) of plant material from the byre (Figure 42). The next step is to identify those type one samples that are related to the formation of the byre assemblage (Figure 43). The third step is to analyze both type one and two samples (Appendix 5) and calculate the percentages of macrofossil and pollen remains. Finally, the composition of the two sample types must be compared (Figure 44).

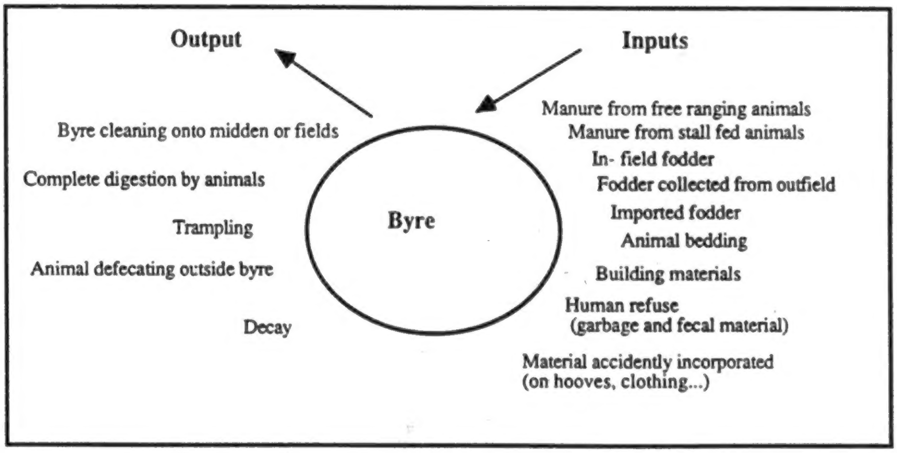

Output
Inputs
Byre cleaning onto midden or fields
Complete digestion by animals
Trampling
Animal defecating outside byre
Decay
Byre
Manure from free ranging animals
Manure from stall fed animals
In- field fodder
Fodder collected from outfield
Imported fodder
Animal bedding
Building materials
Human refuse
(garbage and fecal material)
Material accidently incorporated
(on hooves, clothing...)

Figure 42. Sources of botanical remains and formation processes in a Norse Greenlandic byre.

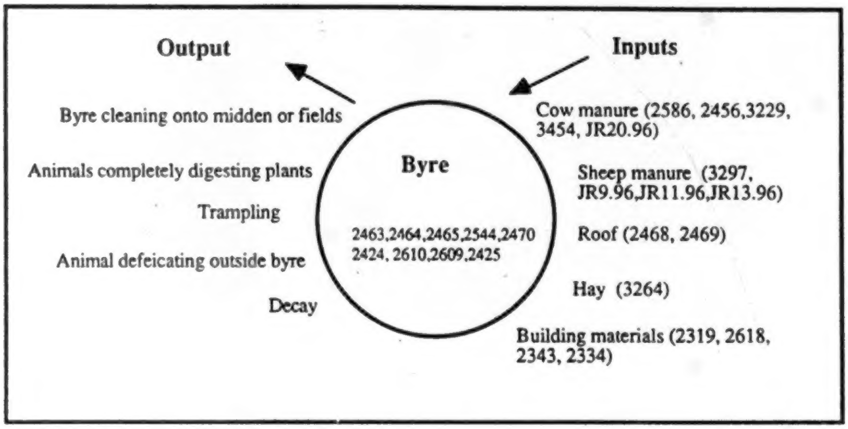

Output
Inputs
Byre cleaning onto midden or fields
Animals completely digesting plants
Trampling
Animal defeicating outside byre
Decay
Byre
2463,2464,2465,2544,2470
2424, 2610,2609,2425
Cow manure (2586, 2456,3229, 3454, JR20.96)
Sheep manure (3297, JR9.96,JR11.96,JR13.96)
Roof (2468, 2469)
Hay (3264)
Building materials (2319, 2618, 2343, 2334)

Figure 43. GUS samples associated with formation process of a Norse Greenlandic byre

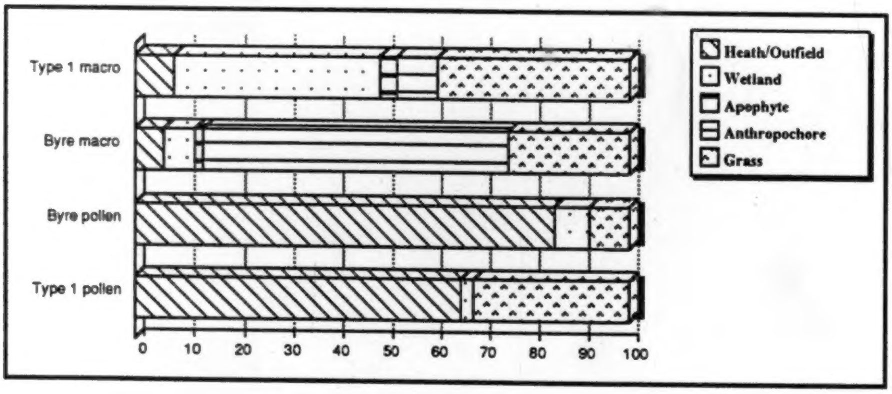


Figure 44. Paleoethnobotanical remains from type one samples combined to contrast the paleoethnobotanical remains of the byre a type two sample.

The bar graphs for type one samples and the byre samples are similar but not exact. The two lower bars represent the pollen samples and are both dominated by Heath/Outfield group followed by Grass and Wetlands groups. The top bars represent the macroremains samples which differ greatly in the amounts of Wetland and Anthropochore groups present. Based on the type one samples from GUS, the Wetland group appears to be underrepresented in the byre macrobotanical remains. Wetland plants may have been removed somehow from the byre floor. Livestock may have consumed the plants. This is supported by the fact that the type one sample that has the greatest concentration of wetland species is the proposed hay sample (Figure 45) which reflect the ideal fodder for modern sheep. The Anthropochore group is over-represented in the byre floor when compared to the analysis of type one samples. The predominance of Anthropochores in type two floor samples and the relative absence of Anthropochores in type one samples indicates that these remains must come from an unidentified source such as a "natural control" sample or a type one sample that has not yet been collected or processed. If the Anthropochore sources had been identified in a "natural control" sample, they could be classified as the total sum of the "noise". The presence of the anthropochores would then suggest that the surrounding vegetation was dominated by these plants (Robinson 1987). If the anthropochores are from a type one sample that has not been collected, more effort must be given to identifying the formation process responsible for the deposition (input) of the anthropochores. The anthropochore group might have been utilized selectively for flooring material and thus the type one sample for this group would be characterized as a byre floor prior to use, a sample that will not likely be found in an archaeological farm site.

If the type one samples are considered on an individual basis they can be used to assist in making more specific interpretations of the paleoethnobotanical assemblage found in byre floor samples (Figure 45). The Hay/Grass sample, 3264, would contribute Cyperaceae and Gramineae remains. The caprine manure would contribute Cyperaceae macroremains and the Betulaceae and Salicaceae found in the pollen record. The cow manure would also contribute remains from Betulaceae and Salicaceae, and Gramineae seeds, likely in a fragmented state. The peat blocks would contribute Heathland/Outfield plants, including leaf buds and other plant taxa. Only the turf block would contribute Anthropochores to the floor of the byre (Figure 45).

The above demonstration of Strategy Five is admittedly limited but serves to outline its potential. This demonstration would have been more informative had "natural control" samples been collected. However, it would have been problematic to retrieve "natural" samples from around GUS as any soils associated with the Norse occupation of the area would probably have been influenced by anthropogenic sediment and would have provided no more of a "natural" sample than those taken on-site. As the surface sediments of the site has also changed, it is unlikely that the plant communities now found around the site would be the same as those from the past. In this case the use of "natural control" samples may have added more variables than they would have eliminated.

Strategy Five is an appropriate response to claims that there is too much "noise" and the formation processes are too numerous to make specific interpretations about plant use (Buckland *et al.* 1983; Fredskild and Humle 1991). If type two samples are to be the basis of paleoethnobotanical

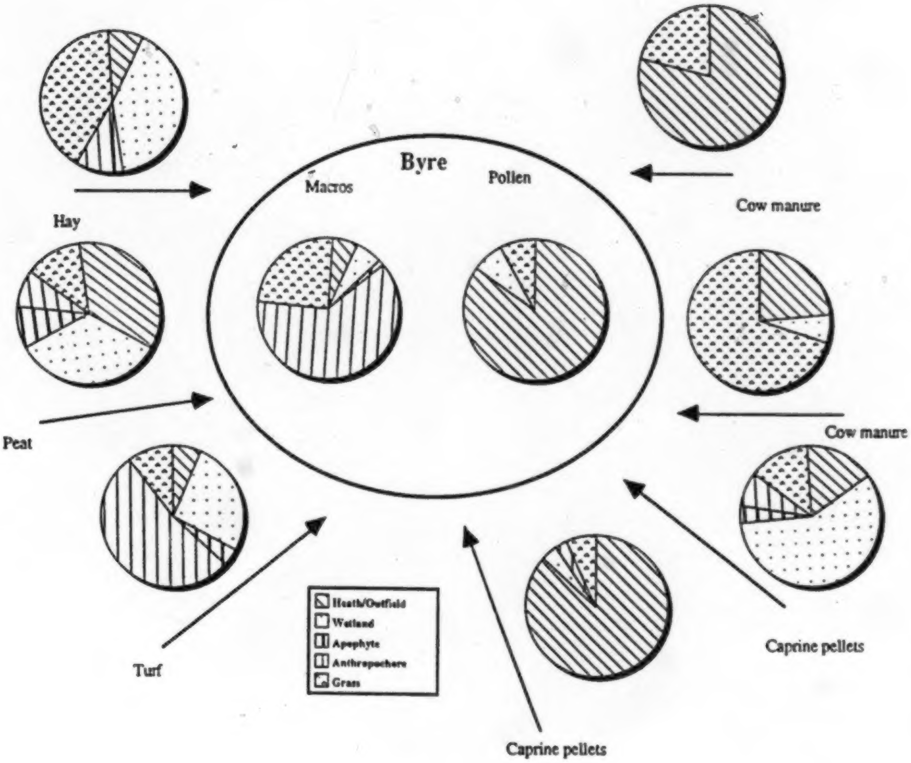


Figure 45. Pie diagrams of GUS samples used to demonstrate Strategy Five. Pie graphs for the byre samples are composites of all samples analyzed for macro and pollen respectively. The pie graphs around the outside are those for the type one samples analyzed. The peat blocks samples were combined and the caprine and manure samples were combined to depict the two most common diet patterns The arrangement of this figure is such that all pollen samples are on the right and all the macrofossil samples are on the left.

research in Greenland, then interpretations will be limited to ubiquity studies (Popper 1988) and a generalized Norse plant use strategy. Strategy Five is a promising methodology that can assist in identifying patterns of vegetation use for specific purposes such as construction material, fuel and fodder. If patterns of vegetation use emerge from an analysis of type one samples, then these patterns can be used to make more specific interpretations about sources or use of plant material before it was deposited in a type two context. Strategy Five can be applied when finances and time are limited as samples can be ranked in terms of their information potential.

If this sampling strategy is implemented as a standard method for Greenlandic paleoethnobotany, a complementary data set can be developed so that the remains from different sites can be more directly compared. In this way type one samples from one site could provide the basis for the interpretation of type two samples from another site. The underlying assumption is that the botanical remains in turf blocks, peat blocks, and roofing materials would be relatively uniform in their composition between sites within the same settlement, an assumption that will have to be tested. Type one samples, such as hay, are less likely to have a uniform composition as hay composition is likely dependent on the resources of each farmstead, which would be influenced by its status and geography.

The fact that this strategy seems to be promising in an area where the botanical remains are limited in diversity, indicates that it may be applied with even greater success in more temperate areas where botanical remains will be more diverse. This strategy will be improved upon by having more type one samples examined to determine if patterns can be established over a larger number of samples.

CHAPTER 7 SUMMARY

Greenland in the late tenth century was settled by the Norse from Iceland. These settlers were farmers and settled the areas of southwest Greenland most suitable for an agriculture economy. Although agriculture with a focus on animal husbandry was important, it was not the only subsistence activity as the Norse also hunted marine and terrestrial animals.

Several studies have been done concerning the use of *sæters* (Albrethsen and Keller 1986, Albrethsen 1991), changes in vegetation coverage (Fredskild 1973), resource potential (Christensen-Bojsen 1991a, 1991a; Hansen 1991) and soils (Jacobsen 1987; Jakobsen 1991; Rutherford 1995). How these elements interact with the archaeological record to provide a complete picture of the Norse agricultural and environmental systems has yet to be synthesized. The main objective of farm activity would be to provide the livestock with the quantity and quality of fodder that would ensure the animals remained productive. In Greenland the livestock was used predominately for secondary products such as milk and wool. The Norse provided their animals with fodder by using infields and outfields. To date we know that the infields were cleared of vegetation by burning and/or cutting the vegetation. These fields were then fertilized with manure and some fields were irrigated. We have no evidence of the fields being sown with a particular hay crop or that maintenance activity occurred other than the spring episode of manuring and on some farms the use of irrigation. Since disturbed areas were created anthropochores became established. The size of the infields would depend on the status of the landowner and at what point in

Norse Greenlandic history settlement occurred. Garðar, the most prestigious farmstead in Greenland, did not have an infield large enough to support the 107 cows that could be byred in its barns. It is unlikely that any farmstead had an infield large enough to completely supply its animals with winter fodder. This meant that additional fodder had to be obtained by other means.

The outfield is the most likely location from which additional fodder would have been collected. Specifically, how the outfields were used is unknown and will likely remain so until potential *sæters* are excavated. The outfields might have been used for two purposes. Animals were likely led into the outfield to graze from early spring to early autumn. Placing the animals in the outfield to graze would protect the productive infield from the livestock. The second main use of the outfield was the harvesting of twig and leaf fodder, and highland grass.

Irrigation channels have been discovered at some Norse Greenlandic sites. The effects these irrigation channels had on the infield were likely positive resulting in greater crop yields but the way irrigation channels changed drainage patterns and vegetation of an area has not been investigated. Cores from Comaium Moes and Galium Kær show a drop in the water table (Fredskild 1987, 1989) associated with an increase in dwarf shrubs. Dwarf shrubs, as documented in the pollen analysis of both caprine and cow fecal material, are important to the Norse agricultural system. In my opinion, the Norse Greenlanders could have been using the irrigation systems to manage both infield and outfield vegetation; watering one area and draining the other.

As *landnám* occurred during a period of dry, warm climate and abandonment occurred in a cooler, moister period, how these two climate factors altered specific vegetation types will be key to understanding how the climate changes would have stressed a Norse farmstead. To what extent the Norse used wetland and dry land vegetation and for what specific purpose should also be further investigated.

The seasonality of subsistence activities makes it apparent that a great deal of work had to be done during the short Greenlandic summer. In light of Lynnerup's (1996) low estimate for the Norse Greenlandic population, even at the height of the Norse settlement, it is unlikely that there would be enough men in the Western settlement to complete all the hunting and farming for both market and subsistence economies in the time available. Women very likely contributed a considerable amount of the labour not only within the farmstead weaving and making cheese, but also in the infields and outfields. The role of women in the Norse economy of Greenland has not been fully recognized, although their role is recognized in other Scandinavian archaeological research (Dommasnes 1982).

By the 15th century the Norse had abandoned their Greenlandic settlements. Of the many causes of abandonment proposed, infestation by caterpillars, climatic change and non-sustainable land use practices could have resulted in changes to the paleoethnobotanical record. There are remains of insects (possibly caterpillars) in the GUS samples I have investigated but interpretation of these remains is forthcoming (Buckland in progress). Also, the samples analyzed cannot be used to make definite statements about climate change as each sample contains remains from a number of different plant communities. There is no evidence for soil erosion due to poor land use practices at GUS, although work is still in progress in this area (Schweger, in progress).

The GUS archaeological site is situated in the Western Settlement at the end of Ameralla fjord on the north side of the valley. The site was sealed under about one metre of alluvium with permafrost below. Due to the site's encasement, organic preservation is excellent and is of a waterlogged nature. A hundred and thirty-nine samples were collected from within and around the GUS site; the analysis of 42 samples is presented in this thesis. Thirteen of these samples were analyzed using standard pollen methodology and the others were investigated by archaeobotanical methods.

The excellent preservation of the archaeobotanical material and the generalized nature of Norse plant use led to concerns about the interpretation of the paleoethnobotanical material. Most sites investigated for archaeobotanical material focus on charred remains. It is assumed that charred remains are more likely to be part of an archaeological matrix as a result of anthropogenic activity and not the result of the natural seed rain during site occupation or post occupation formation processes. Paleoethnobotanical investigation also tends to focus on cultigens, edible wild plants or climatic conditions during site occupation. The GUS archaeobotanical assemblage is not suitable for such an approach nor are most Norse Greenlandic archaeological sites. The Norse Greenlanders, as far as we know, were not able to grow cultigens, and although there are edible wild plants available, their presence in an assemblage is not significant enough to form the basis of paleoethnobotanical research. Statements about the environment are better derived from peat and lake pollen cores as the formation processes involved in the creation of a Norse Greenlandic archaeobotanical assemblage results in plants with many ecological origins being found in one sample. But the Norse dependencies on plants for building material and to feed their livestock makes them key resources and so it is essential to illuminate in great detail Norse plant use in Greenland.

Fredskild and Humle (1991:80) recognized "the obvious difficulties in interpreting ecological, climatic, cultural and other aspects of samples from cultural layers" and states that "pollen and macrofossil analysis may not be an entire waste of time especially if combined with other paleoecological analysis" (Fredskild and Humle 1991:80). They also state that "considering the very time consuming nature of the work, it is important that the archaeologist ask clear questions about a limited number of selected samples" (Fredskild and Humle 1991:80). As paleoethnobotany is a relative young field compared to archaeology; new methodologies must always be considered and statements of the impossible should not be made until new methods have been explored. The sampling Strategy Five which I have suggested is a new methodology that has not been tested. This sampling strategy requires that the formation processes of a archaeobotanical assemblage be determined. Once the formation processes have been determined, very select type one samples related to the formation processes can be chosen for analysis. These type one samples can be used to determine what part of the more general type two samples, which Fredskild refers to as cultural layers, are the result of cultural formation processes and which are the result of "noise". "Noise" defined here includes plant remains that are natural deposits or the result of indirect cultural use. Strategy Five then deals with Fredskild's concerns as it requires identification of formation processes and investigation of selected samples such as hearth content, manure or peat blocks. Investigation of these samples requires that specific question be asked such as the type of fuel used or the diet of the livestock and not simply what is the sample composition and what can be said about it. Type one samples can then be used to assist in interpreting remains from more general cultural layers. In this way paleoethnobotany can be used to its fullest potential.

The demonstration of Strategy Five was based on the byre samples and all the type one samples and although it is not an extensive demonstration it is promising. The paleoethnobotanical assemblages from type one samples could be used to account for almost all of the paleoethnobotanical assemblage found in the combined byre samples. Wetland species are underrepresented in the byre samples compared to what would be expected from the analysis of type one samples. This is potentially the result of the livestock eating wetland plants thus removing them from the archaeological record. Anthropochores made up a higher percentage in the byre samples than would be expected from the analysis of type one samples. The over-representation of anthropochores may be due to an independent source of these plants which was not sampled.

Archaeobotanical remains were examined from the long house, living rooms, animal rooms, manure samples and construction material.
The results from the long house samples are very important as this is the first long house to be sampled for archaeobotanical remains. These samples were informative and future archaeological investigation will help to establish if any patterns will emerge. In the long house there seems to be an alternation between the use of twig matting and sedge matting as flooring. There also appears to be a difference in fuels used between the cooking pit which contains mostly wetland species and the central hearth which contains plants from the Heath/Outfield group. Floors and hearths from other sites should be sampled to determine if these results will develop into a pattern. Apophytes and anthropochores are evident in small numbers in the long house samples which indicates either that the long house structure was built after an earlier *Landnám* period, or that these weeds established themselves quickly within the first building phase of GUS. The floors from living and animal rooms are

dominated by anthropochores. This domination may be the result of the prolific nature of these plants or it is possible that anthropochores had value only as raw material. Because dung is such a common find in Norse sites a continued investigation of this material will establish which plant communities were used by the animals and also determine if there are any changes in the availability of vegetation. The present data points to different diets for the caprines. One is very homogeneous and consists mostly of plants from the Heath/Outfield group including *Salix*, *Betula* and *Alnus*, and may indicate that the animals were stall fed. The other diet is more mixed with a high proportion of grass possible indicating the animals were free ranging. Cow diet, as determined by the analysis of manure, is predominately grass followed by plants in the Heath/Outfield group. The peat, turf and manure wall fill samples all contained such a mixture of plant groups that it is not possible to determine where exactly these building materials were obtained. The peat samples likely came from the outfield as plants from the Heath/Outfield group dominate while the turf block possibly came from the infield as anthropochores dominate. The manure wall fill is most similar to samples taken from rooms possibly used to house sheep so this fill may have come from a sheep shed.

Because a limited number of taxa seem to be used for a variety of very important purposes such as building material, fuel and fodder, paleoethnobotanical investigations in Greenland should not depend on type two samples from cultural layers. Analysis based on general samples will only result in general statements that the plants found could be the result of numerous formation processes but can tell us nothing specific. Specific questions based on specific samples must be asked. There is great potential for paleoethnobotanical work in Greenland if appropriate question are asked.

Some of these question are as follows: (1) Were the animals free-ranging or stall fed? This question can be answered by examined manure to see if the plant remains are homogeneous or heterogeneous, assuming that the animals were penned at night (Albrethsen and Keller 1986). (2) When and from where were twig and leaf fodder collected? This can be answered by investigating seasonal rings from large twigs and caprine pellets (Rassmusen 1993). (3) What local resources if any were used for roofing material? Samples taken from archaeological roof remains should be examined for twig type and size as well as seed remains to answer this question. (4) What plant communities were the sources of peat and turf blocks used for building and would their removal effect the land available for animals to graze on? To answer this question more individual peat and turf blocks should be sampled. (5) Were the Norse more dependent on wetland or dryland communities? Grass and sedge identified to species could answer this question. (6) What type of plant material was being burned as fuel and is there a change in the plant material use though time or between features? The sampling of hearth and cooking areas can be used to answer these questions. It is evident that there are many questions that can be directed to Greenlandic archaeobotanical assemblages; this reinforces the important place paleoethnobotanical studies should hold if the subsistence activities of the Norse are to be fully depicted.

Bibliography

Albrethsen, S. E.
1991 Saeterburg In the Norse Eastern Settlement" Østebygden" in South West Greenland. *Acta Borealia* 1:15-27.

Albrethsen, S. E., and C. Keller
1986 The Use of the *Saeter* in Medieval Norse Farming in Greenland. *Arctic Anthropology* 23(1/2):91-109.

Andreasen, C., and J. Arneborg
1992 Gården Under Sandet - Undersøgelserne 1991. *Forsking i Grønland /Tusaat* 1:10-18.

Arneborg, J.
1991a The Niquusat excavation reconsidered. *Acta Borealia* 1:78-87.

Arneborg, J.
1991b The Roman Church in Norse Greenland. *Acta Archaeologica* 61:142-150.

Arneborg, J.
1993 Contact Between Eskimo and Norsemen in Greenland- a review of the evidence. Tolvte tvaefaglige Vikingsymposium 23-35 Aarhus Universitet, Moesgaard.

Arneborg, J.
1996a Gården Under Sandet: The Farm Beneath the Sand, Nuuk-Greenland Archaeological Investigation 1996 Documentation-Plans.Copenhagen: The National Museum of Denmark.

Arneborg, J.
1996b Gården Under Sandet: The Farm Beneath the Sand, Nuuk-Greenland Archaeological Investigation 1996 Documentation- The finds Copenhagen: The National Museum of Denmark.

Arneborg, J., and J. Berglund
1993 Gården Under Sandet. *Forskning Grønland/Tusaat* 4:7-19.

Arneborg, J., and J.Berglund
1994 Gården Under Sandet. Arkaeologiske undersøgelser af nordbogård i Grønlands Vesterbygd Nuup Kommunea STATUS Januar 1994. Nuuk: Greenland National Museum and Archives.

Arneborg, J., and J. Berglund
1995 Gården Under Sandet. Arkaeologiske undersøgelser af nordbogård i Grønlands Vesterbygd Nuup Kommunea STATUS december 1995. Nuuk: Greenland National Museum and Archives.

Arnold, D. E.
1958 *Ceramic Theory and Cultural Process.* Cambridge University Press, Cambridge.

Ball, B., and P. T. Bobrowsky
1987 Cost effectiveness and Time Management Evaluation of Intensive Recovery Techniques. *Canadian Journal of Archaeology* 11:75-96.

Bard, J.
1954 *Report on Greenland.* The Prime Minister's Second Department. The Greenlandic Department, Copenhagen.

Bayman, J.M., M. R. Palacios-Fest and L.W. Huckell
1997 Botanical Signatures of Water Storage Duration in a Hohkam Reservoir. *American Antiquity* 62(1):103-111.

Begler, E. B., and R. W. Keatinge
1979 Theoretical goals and methodological realties: problems in reconstruction of prehistoric subsistence economies. *World Archaeology* 11(2):208-226.

Behre, K-E, and S. Jacomet
1991 The ecological interpretation of archaeological data. In *Progress in Old World Paleoethnobotany*, edited by Willem Van Zeist, Krystyna Wasylikowea and Karl-Ernst Behre, pp. 81-108. A.A. Balkema, Rotterdam.

Beijerink, W.
1947 *Zadenatlas Der Nederlandsche Flora.* H. Veenman and Zonen, Wageningen.

Berggren, G.
1969 *Atlas of Seeds, Pt 2 &3.* Swedish Natural Science Research Council, Stockholm.

Berglund, J.
1986 The Decline of the Norse Settlement in Greenland. *Arctic Anthropology* 23(1/2):109-136.

Bocquet, A., J.L. Brochier, A. Emery-Barbier, K. Lundstrom-Baudais, Christian Orcel, and Françoise Vin
1987 A submerged Neolithic village: Charavines 'Les Baigneurs'in Lake Paladru, France. In *European Wetlands in Prehistory*, edited by John M. Coles and Andrew J. Lawson, pp. 22- 54. Clarendon Press, Oxford.

Boniface, C.
1981 *The Flora of Farms In Iceland.* Honours Paper Dept. Geography, University of Birmingham.

Book of Settlements, The (Landnámabók).
1972 Translated by H. Pálsson and P. Edwards. University of Manitoba Press, Manitoba.

Botteman, S.
1984 The composition of modern charred seed assemblage. In *Plant and Ancient Man Studies in Paleoethnobotany*, edited by W Zan Zeist and W.A. Casparie pp. 207- 212 A.A. Balkema, Rotterdam.

Buckland, P. C., G. Sveinbjarnardottir, D.Savory, T. McGovern, P. Skidmore, and C. Andreasen
1983 Norsemen at Nipaitsoq, Greenland: A Palaecological Investigation. *Norwegian Archaeological Review* 16(2)86-98.

Buckland P.C., T Amorosi, L.K. Barlow, A.J. Dugmore, P.A. Mayewski, T.H. Mc Govern, A.E.J. Ogilvie, J.P. Sadler, and D. Skidmore
1996 Bioarchaeological and Climatological evidence for the fate of the Norse farmers in medieval Greenland. *Antiquity* 70: 88-96.

Bruun, D.
1918 The Icelandic colonization of Greenland and the Finding of Vinland *Meddelelser Om Grønland* Bd. 57 .

Böcher, Tyge W., K. Holmen, and K. Jakobsen
1968 *The Flora of Greenland.* P. Haase and Son Publishers,Copenhagen.

Christensen-Bojsen, K. M.
1991a Land use and resources exploitation in the Norse Western Settlement in Greenland. *Acta Borealia* 1: 28-37.

Christensen-Bojsen, K. M.
1991b Aspects of the Norse Economy in the Western Settlement Greenland. *Acta Archaeologica* 61:158-165.

Clapham, A.J., and R. G. Scaife
1988 A pollen and plant macrofossil investigation of Oakbank Crannog, Loch Tay Scotland. In *The Exploitation of Wetlands.* edited by Peter Murphy and Charles French pp.293-325 BAR British Series 186.

Clifford, H. F.
1991 *Aquatic Invertebrates of Alberta.* The University of Alberta Press, Edmonton.

Coles, J.
1984 *The Archaeology of Wetlands.* Edinburgh University Press, Edinburgh.

Delorit, R.
1970 *Illustrated Taxonomy Manual of Weed Seeds.* Agronomy Publications, River Falls Wisconsin.

Dennell, R.W.
1976 The Economic Importance of Plant Resources presented on Archaeological Sites. *Journal of Archaeological Science* 3: 229-247.

Dimbleby, G.
1978 *Plants and Archaeology.* John Baker, London.

Dommasnes, L.H.
1982 Late Iron Age In Western Norway: Female Roles and Rank as Deduced from an Analysis of Burial Custom. In *Norwegian Archaeological Review.* 15 1/2: 70-78.

Feilberg, J., B.Fredskild and S.Holt,
1984 *Grønlands Blomster (Flowers of Greenland)* Bogtryk & Offset, Ringsted.

Fenton, A.
1978 *The Northern Isles: Orkney and Shetland.* John Donald Publishers Ltd. Edinburgh.

Fitter, R., A. Fitter, and M. Blamey
1978 *The Wild Flowers of Britain and Northern Europe.* William Collins Sons & Co. Ltd., Glasgow.

Foersom, Th., F. O. Kapel and O. Svarre
1982 *Nunatta Naasui Grønlands flora i farver.* Mette and Eric Mourier.

Ford, R. I.,
1988 Commentary: Little things Mean a Lot-Quantification and Qualification in Paleoethnobotany*Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains.* edited by Christine A. Hastrof and Virginia S. Popper pp. 215-227. University of Chicago Press, Chicago.

Fredskild, B.
1967 Paleobotanical Investigations at Sermermiut, Jakobshaven, West Greenland. *Meddelelser Om Grønland* Bd 178. Nr. 4. Copenhagen.

1973 Studies in the Vegetational History of Greenland: Paleobotanical Investigations of some Holocene Lake and Bog Deposits. Meddelelser Om Grønland Bd 198. Nr. 4. Copenhagen.

1978 Paleobotanical Investigations of Some Peat Deposits of Norse Age at Qagssiarssuk, South Greenland. *Meddelser om Grønland.* Bd.204 No.5.

1983a The Holocene Vegetational Development of the Godthåbsfjord Area, West Greenland. *Meddelser om Grønland, Geoscience* 10:3-28.

1983b The Holocene development of some low and high Arctic Greenland lakes. *Hydrobiologia* 103, 217-224.

1985 Holocene Pollen record from Western Greenland In *Quaternary Environments: Eastern Canadian Arctic, Baffin Bay and Western Greenland.* edited by J.T. Andrews, pp. 644-681 Boston: Allen and Unwin.

1988 Agriculture in a Marginal area- South Greenland from the Norse Landnam (985 A.D.) to the present (1985 A.D.) In *Cultural Landscapes-Past, Present and Future*. edited by Hillary Birks, H.J.B. Birks, Peter Emil Kaland and Dagfinn Moe, pp. 381-393. Cambridge: Cambridge University Press.

1989 The Natural Environment of the Norse Settlers in Greenland. In *Early European Exploitation of the North Atlantic 800 A.D -1700 A.D*. Pp. 27-42. The Netherlands: Arctic Center University of Groningen Netherlands.

1991 The Genus *Betula* in Greenland- Holocene History, Present Distribution and Synecology. *Nordic Journal of Botany* 11(4)393-412.

1992 Erosion and Vegetation Changes in South Greenland Caused by Agriculture. *Geografisk Tidsskrift* 92:14-21.

Fredskild, B. and L. Humle
1991 Plant Remains from the Norse farm Sandnes in the Western Settlement, Greenland. *Acta Borealia* 69-81.

Fægri, K. and Johs. Iversen
1975 *Textbook of Pollen Analysis* 3rd edition. Munksgaard, Copenhagen.

Gad, F.
1970 *History of Greenland Vol.1 Earliest times to 1700*. London: London and Hust Company.

Green, F.
1982. Problems of interpreting differential preserved plant remains from urban excavations of medieval urban sites In A.R. Hall and H.K Kenward *Environmental Archaeology in the Urban context research report* no. 43: 40-46 The council for British Archaeology Lonsdale Universal Printing. Bath Avon.

Greig, J.
1981 The Investigation of a Mediaeval Barrel-latrine from Worcester. *Journal of Archaeological Science* 8: 265-282.

Greig, J.
1984 The paleoecology of some British hay meadows types. In *Plant and Ancient Man Studies in Paleoethnobotany.* edited by W Van Zeist and W.A. Casparie. pp 213-226 A.A. Balkema, Rotterdam.

Groves, J.N, and R. Switsur
1994 Glacial geological Evidences for the Medieval Warm period. *Climatic Change* 26:143-169.

Gullvø, H. C.
1983 The Eskimo View of the European: The so called Norse doll and other questionable carvings. *Arctic Anthropology* 20 (2):121-129.

Hally, D. J.
1981. Plants and the content of Paleobotanical samples a Case study. *American Antiquity* 46 (4) 723-742.

Hansen, B. U.
1991 Using Climate and Vegetation studies in Southern Greenland to estimate the natural resources in the Norse Period. *Acta Borealia* 1: 38-51.

Harris, B. C.
1968 *Eat the Weeds.* Barre Publishers, Massachusetts.

Hastrup,
1989 *Saeters* in Iceland A.D. 900-1600. *Acta Borealia* 1:72-85.

Ingstad, H.
1969 *Westward to Vinland: The Discovery of pre-Columbian Norse House Sites in North America.* Toronto: Macmillan Company of Canada Limited.

Jacobsen, N K.
1987 Studies on Soil and Potential for Soil Erosion in the Sheep Farming Areas of Southern Greenland. *Arctic and Alpine Research* 19(4) 498-507.

Jakobsen, B.H.
1991 Soil resources and soil erosion in the Norse Settlement area Østebygden in South Greenland. *Acta Borealia* 1:52-65.

Jansen, H.M
1972 A Critical Account of the Written and Archaeological Sources Evidence Concerning the Norse Settlement Of Greenland. *Meddelelser Om Grønland* Bd. 182 No.4, Copenhagen.

Jones, G.
1986 *The Norse Atlantic Saga; Beginning the Norse Voyage of Discovery and Settlement to Iceland Greenland and North America.* 2nd. ed. Oxford: Oxford University Press.

Jones, G.
1987 *A History of the Vikings* 2nd Edition. Oxford: Oxford University Press.

Jørgensen, G.
1986 Medieval Plant Remains from the Settlement in Mollergade 6 *The Archaeology of Svendborg* 4: 45-84.

Jørgensen, J.B., K. Hansen and A.Ø. Hansen,
1978 Demographic Studies in Two Villages in the Upernavik District. *Meddelelser Om Grønland* Bd. 202 No.3, Copenhagen.

Kammp, AA. H.,
1978 Some problems of rural development in Faroes and Greenland. In *Rural development in Highland and high -latitude zones.* edited by Leo Kout Aniemi, pp. 125-138 Nordia Vol. 12, No. 1.,Oulu.

Kapel, H. C.
1991 *Nyopdaget Nordbogård i Vesterbygen.* Forskining i Grønland/ Tusaat 1/91.

Keller, C.
1991 Vikings in the West Atlantic: A Model of Norse Greenlandic Medieval Society. *Acta Archaeologica.* 61:126-141.

Knuth, E.
n.d. *Aron of Kangek The Norsemen and the Skraelings.* Det Grønlandske Forlag, Godthåb.

Kremp, G. O.W.,
1968 *Morphologic Encyclopedia of Palynology.* University of Arizona Press, Tucson.

Krogh, K. J
1967 *Viking Greenland: With a Supplement of Saga Text.* Copenhagen: The National Museum.

Larsen, K.
1950 *A History of Norway.* Princeton University Press, New York.

Lennstrom, H. A., and C. A. Hastof
1995 "Interpretation in context: sampling and analysis in Paleoethnobotany. *American Antiquity* 60(4)701-721.

Lynnerup, N.
1991 The Norse Setters in Greenland- the physical anthropological perspective. *Acta Borealia.* 1:88-91.

Lynnerup, N.
1996 Paleodemography of The Greenland Norse. *Arctic Anthropology* 33(2)122-136.

Lynnerup,N., J. Arneborg, J.P. Hart Hansen
1990 Norse Anthropological Remains. In *Polar Record* 27(161):132-133.

Magnusson, M.. and H. Pálsson,
1965 *The Vinland Saga.* New York; Penguin Books.

Martin, A., and W. Barwkley
1961 *Seed Identification Manual.* University of California Press, Berkeley.

McGhee, R.
1987 The Relations Between the Medieval Norse and the Eskimo. In *Between Greenland and America: Cross cultural contacts and the Environment in the Baffin Bay Area*, edited by Louwrens Harquebord and Richard Vaghan, pp. 51-61. The Netherlands: Arctic Center University of Groningen Netherlands.

McGhee, R., and M. Einarsson
1983 Greenlandic Eskimo and Norse: A Parallel Tradition from Greenland and Iceland. *Folk* 25: 51-61.

McGovern, T.

1980 Cows, Harp Seals and Church bells; Adaptation and Extinction in Norse Greenland. *Human Ecology* 8(3)245-275.

1981 The economics of Extinction in Norse Greenland In *Climate and History: Studies in past climates and their impact on man.* edited by T.M.L. Wigley, M.J. Ingram and G. Farmer, pp.404-433 Cambridge University Press, Cambridge.

1984 From Zooarchaeology to Paleoeconomy: A case from Norse Greenland. *MASCA Journal* 3(2)36-40.

1985 The Arctic Frontier of Norse Greenland In *The Archeology of Frontiers and Boundaries*, Editor by S. Green and S. Perlman, pp. 275-323 N.Y.: Academic Press.

1987 A Comparison of the Greenlandic Eastern and Western Settlements. *Hikuin* 27-36.

1990 The Archaeology of the Norse North Atlantic. *Annual Review Anthropology* 19:331-351.

1991 Climate Correlation and Causation in Norse Greenland. *Arctic Anthropology*. 28(2):77-100.

1992 Bones Buildings and Boundaries: Paleoeconomic Approaches to Norse Greenland. In *Norse and later Settlements and Subsistence in the North Atlantic*. edited by Christopher Morris and D. James Rackham pp. 193-229. Glasgow: University of Glasgow.

1993a Management for Extinction in Norse Greenland. In *Historical Ecology*,edited by Carol Crumley, pp. 127-154. Santa Fe: School of American Research Press.

1993b Rooms and Refuse in Norse Greenland: Some patterns of Accumulation. NABO draft.

McGovern, T., and T. Amorosi, S. Perdikaris, J.Woollett

1996 Vertebrate Zooarchaeology of Sandnes V 51: Economic Change at a Chieftain's Farm in Western Greenland. *Arctic Anthropology* 33(2)94-121.

McGovern, T.H., and Barlow, Buckland, Ogilvie, Skidemore
1995 Dogs, Doors, and Thresholds: Climate Change and the death of the Norse Western Settlement in Greenland. Paper presented at 1995 Society of American Archaeology conference.

McGovern, T. H., and G.F. Bigelow,
1984 The Zooarchaeology of the Norse site Ø17a Narssaq district, Southwest Greenland. *Acta Borealia* (1)1:85-102.

McGovern, T.H. G.F. Bigelow, T. Amorosi and D. Russel
1988 Northern Islands, Human Error and Environmental Degradation: A View of Social and Ecological Change in Medieval North Atlantic. *Human Ecology* 16(3)225-270.

McGovern, T., P. C Buckland, G. Sveinbjarnardottir, D. Savory, P. Skidmore, and C. Andreasen
1983 A Study of the Faunal and Floral Remains From Two Norse Farms in the Western Settlement Greenland. *Arctic Anthropology* 20 (2):28-120.

McGovern, T., and R. Jordan
1982 Settlement and land use in the inner Fjords of Gothaab District , Western Greenland. *Arctic Anthropology* 19(1):62-79.

Meldgaard, J.
1976 The Prehistoric Cultures In Greenland: Discontinuity in a marginal Region In Continuity and Discontinuity in the Inuit Culture of Greenland edited by Hans P. Kylstra and Lies H. Liefferink pp. 19- 52 The Netherlands: Arctic Center University of Groningen Netherlands.

Miksicek,C. H.
1987 Formation process of the archaeobotanical record In *Advances in Archaeological Method and Theory* Vol. 10 edited by Michael B. Schiffer. pp. 211-247, Academic Press, San Diego.

Miller, N. F. and K. L. Gleason
1994 Fertilizer in the identification and analysis of Cultivated Soil. In *The Archaeology of Garden and Field,* editors Naomi F. Miller & Kathryn L. Gleason. pp. 25-43. University of Pennsylvania Press, Philadelphia.

Minnis, .P E.
1981. Seeds in Archaeological Sites: Sources and Some Interpretive Problems. *American Antiquity* 46(1) 143-151.

Moe, D.
1983 Palynology of Sheep's faeces: relationship between pollen content, diet and local pollen rain. *Grana* 22:105-113.

Montogomery, F.H.
1977 Seeds and fruits of plants of eastern Canada and northeastern United States. University of Toronto Press, Toronto.

Moore, P.D., and J.A.Webb
1978 *An Illustrated Guide to Pollen Analysis.* Hodder and Stoughton, London.

Morlan, R. E.
1980 *Taphonomy and Archaeology in the Upper Pleistocene of the Northern Yukon territory: A Glimpse of the Peopling of the New World* Archaeological Survey of Canada Paper No. 94. National Museum of Canada, Ottawa.

Munson, P., and P. W. Parmalee, R. A. Yarnell
1971. A Subsistence Ecology Scoville: A terminal Middle Woodland Village. *American Antiquity* 36,(4): 410-431.

Nørlund, P.
1936 *Viking settlers in Greenland And Their Descendants During Five Hundred Years.* London: Cambridge University Press.

Nørlund, P., and M. Stenberger.
1934 Brattahild. *Meddelelser Om Grønland* Bd. 88. No. 1 Copenhagen.

O'Brien, S.R. P.A. Mayewski, L.D. Meeker, D.A. Meese, M.S. Twickler, and S.L. Whitlow
1995 Complexity of Holocene Climate as Reconstructed From a Greenland Ice Core. *Science* 270:1962-1964.

Pearsall, D.
1989 *Paleoethnobotany: A Handbook of Procedures.* New York: Academic Press Harcourt, Brace Jovanovich Publishing.

Pedersen, A.

1972 Adventitious Plants and Cultivated Plants in Greenland. *Meddelelser Om Grønland* Bd. 178. No. 7 Copenhagen.

Popper, V. S.

1988 Selecting Quantitative Measurements in Paleoethnobotany. In *Current paleoethnobotany: Analytical methods and Cultural interpretations of Archaeological Plant remains.* edited by Christine A. Hastoff and Virginia S. Popper. University of Chicago Press. Chicago pp. 53-71.

Popper, V. S. and C,H. Hastrof

1988 Intoduction. In *Current paleoethnobotany: Analytical methods and Cultural interpretations of Archaeological Plant remains.* edited by Christine A. Hastoff and Virginia S. Popper. University of Chicago Press. Chicago pp. 1-16.

Rasmussen, P.

1989 Leaf Foddering in the Earliest Neolithic Agriculture Evidence from Switzerland and Denmark. *Acta Archaeologica* 60: 71- 86.

Rasmussen, P.

1993 Analysis Of Goat/Sheep Faeces From Egolzwil 3, Switzerland: Evidences For Branch And Twig Fodder Of Livestock In The Neolithic. *Journal of Archaeological Sciences.* 20:479-502.

Robinson, D.

1984. Plants and Vikings: Everyday Live in the Viking age. *Botany Journal of Scotland* 46(4)542-551.

Robinson, D.

1987. Botanical Remains. In *Excavation in the Medieval Burgh of Perth 1979-1981.* edited by P. Holdsworth pp. 199-209. Society of Antiquaries of Scotland Edinburgh Monograph series Number 5.

Robinson, D.

1996 Priorities in Urban Archaeobotany: some examples from Denmark Nationalmuseets Naturvidenskabelige Undersøgelser Rapport Nr 6.

Robinson, D., H. K.Kristensen, and I. Boldsen

1991. Botanical Analysis from Viborg Søndersø: a waterlogged urban site from the Viking period. *Acta Archaeologica* 62: 59-87.

Robinson, D. and P. H. Mikkelsen
1993 Archaeobotanical investigation at prehistoric settlement sites. Arkæologiske Udgravinger I Denmark.

Robinson, D.,and P. Rasmussen
1989 Botanical Investigation at the Neolithic Lake Village at Weier, North East Switzerland: Leaf, Hay and Cereals as Animal Fodder. In *The Beginnings of Agriculture*. edited by Annie Milles, Diane Williams and Neville Gardner, pp. 149-163. Oxford: BAR International Series 496.

Ross, J. M.
n.d. Arhaeobotanical remains from the long house (room XVII) *Man Nature and Culture in Ancient Greenland*. edited by H Gullvø and Jette Arneborg. Copenhagen, in press.

Roussell, A.
1936 Sandnes and Neighboring Farms. *Meddelelser Om Grønland* Bd. 88(2)1-232.

Roussell, A.
1941 Farms and Churches in the Mediaeval Norse settlements of Greenland. *Meddelelser Om Grønland* Bd 89(1).

Rutherford, D. K.
1995 Soils of Some Norse Settlements in Southwestern Greenland. *Arctic* 48(4):324-328.

Ruppé, R. J.
1988 The Location and Assessment of Underwater Archaeology Sites. In *Wet Site Archaeology* edited by Barbara A. Purdy pp. 55-68. The Telford Press Inc., New Jersey.

Rye, O.
1981 *Pottery Technology Principles and Reconstruction.* Archaeological Reconstruction #4 Taraxacum Inc. Washington.

Sandgren, P., and B. Fredskild
1991 Magnetic measurements recording late Holocene man-induced erosion in S. Greenland. *Boraes* 20:315-331.

Schiffer, M. B .
1987. *Formation Processes of the Archaeological Record.* University of New Mexico, Albuquerque.

Schledermann, P.
1979 Notes Norse Artifacts On Ellesmere Island. *Polar Record* 19(122): 493- 494.

Schledermann, P.
1980 Notes On Norse Finds from the East Coast of Ellesmere Island, NWT. *Arctic*, 33(3):454 463.

Schou, A., and K. Antonsen
1960 Greenland. In *A Geography of Norden* edited by Axel Sømme, pp.140-148. J.W. Cappelens Forlag, Oslo.

Schweger, C.
n.d. Geoarchaeology of the GUS site: A preliminary Framework. *Man Nature and Culture in Ancient Greenland.* edited by H Gullvø and Jette Arneborg. Copenhagen, in press.

Scott, R., and C. M. Halffman
1991 Dental Conditions of Medieval Norsemen in the North Atlantic. *Acta Archaeologica* 62: 183-207.

Smith, C. E.
1967. Plant Remains. In *Prehistoruty of the Prehistory Valley: Vol. I Environment and Subsistence.* edited by Douglas S Byers, pp. 220-255, University of Texas Press, Austin.

Sørensen, I.
1982 Pollenundersøgelser i møddingen på Niaqussat, *Forsking i Grønland /Tusaat* Nr. 8-9 296-302.

Usher, G.
1974 *A Dictionary of Plant Used by Man.* Constable and Company Ltd., London.

Van Der Valk, A.G. ,and C.B. Davis
1979 A Reconstruction of the Recent Vegetation History of A Prairie Marsh, Eagle Lake, Iowa, From its Seed Bank. *Aquatic Botany* 6: 29-51.

Van Der Veen, M.

1984. Sampling for seeds. In *Plant and Ancient Man Studies in Paleoethnobotany*. edited by W Van Zeist and W.A. Casparie. pp. 193-200 A.A. Balkema, Rotterdam.

Van Der Veen, M., and N. Fieller

1982 Sampling Seeds. *Journal of Archaeological Science* 9:287-298.

Van Den Vilsteren,

1984 The medieval village Dommelen: A case study for the interpretation of charred seeds from posthloes. In *Plant and Ancient Man Studies in Paleoethnobotany*. edited by W Bav Zeist W.A. Casparie. pp. 227-236 A.A. Balkema, Rotterdam.

Vebæk, C. L.

1943 Inland Farms in The Norse Eastern Settlement. *Meddelelser on Grønland* Bd. 90 No 1.

1991a Hunting, By Sea and By Land and Fishing in Medieval Norse Greenland. *Acta Borealia* 5-14.

1991b The Church Topography of the Eastern Settlement and the Excavation of the Benedictine Convent at Narsarsuaq in the Uunartoq Fjord. *Meddelelser on Grønland: Man and Society 14*.

Wagner, G. E

1988 Comparability Among Recovery Techniques. *Current Paleoethnobotany: Analytical Methods and Cultural Interpretations of Archaeological Plant Remains*. edited by Christine A. Hastrof and Virginia S. Popper. pp. 17-36. University of Chicago Press, Chicago.

Ward, M. C.

1996 *A World Full of Women*. Allyn & Bacon, Needham, MA.

Whiteford, M.B. and J. Friedl

1992 *The Human Portrait: Introduction to Cultural Anthropology* 3rd edition. Prentice Hall, New Jersey.

Wilson, D. G.
1984. The carbonization of weed seeds and their representation in macrofossil assemblages. In *Plant and Ancient Man Studies in Paleoethnobotany* edited by WVan Zeist and W.A. Casparie. pp. 201-206 A.A. Balkema, Rotterdam.

Woollett, J.
1987 *Settlement, Subsistence and Social Stasis in the Western Settlement of Norse Greenland.* Unpublished Honours BA, Department of Anthropology, University of Alberta, Edmonton.

Zutter, C.
1996 Archaeobotany of Iceland Middens: Comparing the Big and Small. Paper presented at Canadian Archaeological Association Conference, Halifax.

Appendix 1. Norse Sites with Paleoethnobotanical Data.

Site	Context	Number	Investigator	Published Ref #
Eqalugialik	transect		B. Fredskild	2
Ujarassuit	transect	V7	J. Iversen	2, 4
Umiviarssuk	transect	V52	J. Iversen	2, 4
Niaquassat	midden	V48	D. Savory	6
Nipáitsoq	cultural layers	V54	D. Savory	1, 6
			I. Sørensen	7
Sandnes	midden, fen	V51	B. Fredskild	4
GUS	cultural layers		J. Ross	
Brattahilð (Qagssiarssuk)	corn in turf block	Ø29 (?n)	J. Iversen	5, 4
Brattahilð	4 transect	Ø29	B. Fredskild	2
Narssaq	cultural layer	17a	B. Fredskild	2

Pollen Cores	Context	Close to	Investogator	Published Ref.#
Comarum Sø	lake	Ø29	B. Fredskild	2
Comarum Mose	bog	Ø29	B. Fredskild	2
Galium Kær	pond	Ø29	B. Fredskild	2
Johs. Iversen Só	lake	Godhåbjfjord	B. Fredskild	3
Karra	lake	Godhåbjfjord	B. Fredskild	3
Terte lake A	lake	Godhåbjfjord	B. Fredskild	3
Sardlup Qáqâ	lake	Godhåbjfjord	B. Fredskild	3
Tasiussaq	pond	10km W. Brattahilð	B. Fredskild	4

The full reports on these site can be found in the following published material 1) Buckland *et al.* 1983, 2) Fredskild 1973, 3) Fredskild 1985, 4) Fredskild and Humle 1991, 5) Krogh 1967, 6) McGovern *et al.* 1983, 7) Sørensen 1982

Appendix 2. Macroremains found at GUS and other Norse Greenlandic Archaeological Sites

This appendix lists the plant species represented by macroremains (rhizomes, leave, buds, seeds) that have been published from Norse Greenlandic sites. The numbers used are those provided by the author of the published material. These numbers are totals for the site irregardless of the sampling methodology. The Niaquassat and Nipáitsoq numbers are expressed as % of total sample count. The Brattahilð total seed counts include results from 4 transects each with a different sized sample. Data from Sandnes comes from the midden. Data from Eqalugialik, Ujarassuit, Umiviarssuk and Narssaq derived from different samples size which are not always indicated in the publication. Please see original published material for details (Buckland *et al* 1983, Fredskild 1973, Fredskild and Humle 1991 McGovern *et al* 1983).

* indicate presence of macroremains

Plant	GUS	Eqalugialik	Ujarassuit	Umiviarssuk	Niaquassa /100g	Nipáitsoq /100g	Sandnes	Brattahilð (Qagssiarssuk)	Narssaq
Alchemilla alpina								36	*
Alnus crispa	*						*		
Alopecurus aequalis								363	
Angelica			1						
Arctostaphylos uva-ursi							*	3	
Betula nana	*				*	*	*	6	
Brassicaceae							*		
Calamagrostis			*						
Capsella bursa-pastoris	*	26			82.5	143.8	*	31	

Plant	GUS	Eqalugialik	Ujarassuit	Umiviarssuk	Niaquassa /100g	Nipáitsoq /100g	Sandnes	Brattahilð (Qagssiarssuk)	Narssaq
Carex spp.	•		1				•	15	•
C.atrata					•	•		1	
C. bigelowii					74.4	38		59	
C. canescens		7						2	
C. capillaris					•	•			
C. deflexa		2							
C. heleonastes					•	•			
C. norvegica					•				
C. praticola		20							
C. rariflora		23			1.4	•			
Catabrosa aquatica					•	•		145	
Cerastium sp.	•				•	•		1	
Chenopdium sp.	•								
Corylus								1	
Empetrum		20	7					16	•
E. nigrum hermaphroditum	•				41.9	41.4			
Epilobium	•								
Eriophorum	•						•		
Euphrasia		17						1	
Gramineae	•	>100			•	2.6	•		
Hippuris vulgaris	•								
Juncus sp.	•				9.5	•	•		
Juniperus communis	•				•		•	16	
Ledum sp.	•								
Leontodon autumnalis									
Linum usitatissimum					•		•		
Luzula sp.	•	7	13		•	2.5	•		•
Minuartia sp.	•								
Montia fontana	•		140	>1000	37	•	•	468	•
Poa sp.	•								
P. annua								1	
P. pratensis					•	•			

Plant	GUS	Eqalugialik	Ujarassuit	Umiviarssuk	Niaquassat /100g	Nipâitsoq /100g	Sandnes	Brattahilð (Qagssiarssuk)	Narssaq
Polygonum aviculare	*				*	*	*		*
P.boreale		1						80	
P. convolvulus	*								
P. viviparum	*		*						
Potentilla spp.	*	23					*		
P.anserina								5	
P.crantzii	*				*	*			
P.norvegica	*								
P.palustris					*	3.9			
Potamogeton spp..	*								
Ranunculus spp.	*						*		
R. acris								3	
R. confervoides	*								
R. hyperboreus			1300	*	*	*			
Rhinanthus	*							1	
R. minor					*	*			
Rorippa islandica								3	
Rumx acetosella					*	1.3		12	
Salix spp.	*						*	*	
Selaginella					*	*	*	142	*
Sibbaldia			1						
Silene sp.	*								
Stellaria spp.		369	1						
S.media	*				140	132	*	165	*
Taraxacum spp.	*	1			*		*		
Thymus	*								
Vaccinium vitis-idaea	*	1						1	
V. uliginosum								*	
Viola					41.9				*
Viscaria alpina								1	

Appendix 3. List of Archaeobotanical Samples Collected From GUS.

JR #	GUS #	Room	Area	Level	Plan	Depth	Status
1995	1995	1995	1995	1995	1995	1995	1995
JR1.95	2267	1	L		166	533	Analysed
JR 2.95	2266	4b	M		165	532	Analysed
JR3.95	2283	4a	M		165	560	Analysed
JR4.95	---	Rd dung	off site				
JR5.95	---	Rd dung	off site				
JR6.95	---	Rd dung	off site				
JR7.95	---	Rd dung	off site				
JR8.95	2504	4a	L		165	558	
JR9.95	2319	wall	Q		163	598	Analysed
JR10.95	2334	5	Q	fill	163	578	Analysed
JR11.95	2350	16	S		169	554-560	
JR12.95	2324	4b	M		165	536	
JR13.95	---	Mn Pollen	near site	Bug trap A			
JR14.95	---	Mn Pollen	willow	Bug trap D			
JR15.95	2358	4a	M	C	164		
JR16.95	2343	5	Q	peat	170	549	Analysed
JR17.95	2463	3	P-T	28	175	556	Analysed
JR18.95	2464	3	P-T	27	175	560	Analysed
JR19.95	2465	3	P-T	21	175	565	Analysed
JR20.95	2467	16	P-T	4A	175	532	
JR21.95	2466	16	P-T	4E	175	516	
JR22.95	2406	7	Q		165	540	
JR23.95	2405	4b	M				
JR24.95	2544	btwn3/6	P		186	613	Analysed
JR25.95	2468	16	S	upper roof		706	
JR25.5.95	2469	16	S	lower roof		570	
JR26.95	2470	3	P	floor 2	186	527	Analysed
JR27.95	2450	7	Q	floor	163	538	Analysed
JR28.95	2389	4a	M	D	180	573	
JR29.95	2485		P	19	181	590-580	

JR #	GUS #	Room	Area	Level	Plan	Depth	Status
JR30.95	2486		P	24	181	580-554	
JR31.95	2487		P	10	181	554-546	
JR32.95	2424	3	P			520	Analysed
JR33.95	2425	3	P	trough	177	547	Analysed
JR34.95	2484	4a	M	E	first fl	v.4a	Analysed
JR35.95	2410	3/L. hus	P	28	181	597?	
JR36.95	2476	3/L. hus	P		189	508-495	Duplicate
JR37.95	2417	3/L. hus	P	L.hus floor	189	495-485	Analysed
JR38.95	2513		L	fire place	188	528-538	
JR39.95	---	Md Pollen		sloping grass			
JR40.95	---	Md Pollen		near ponds			
JR41.95	2527		L				
JR42.95	2565		H	7	192		
JR43.95	2529	5	M-N				
JR44.95	---	5	M-N				
JR45.95	2380		O			not labled	thrown
JR46.95	2586		O			530	Analysed
JR47.95	2626	18	G		193	548	
JR48.95	2627	18	G	fire place	193		
JR49.95	2618	Wall	G	peat block	193	568	Analysed
JR50.95	2610	3	P	31	175	515	Analysed
JR51.95	2624	19	G		193	563	Analysed
JR52.95	2609	3	P	32	175	505	Analysed
JR53a.95	2588	5	M-N				
JR53b.95	2602	6	P		186	573-567	Analysed
JR54.95	2620		M-L	post hole	193	523	
JR55.95	2604	19		post hole			Analysed
JR56.95	2603	5	M	Bucket		545-535	
JR57.95	---	puff ball	P			near # 2602	
JR58.95	2661	5	M	Bucket		520-510	
JR59.95	2662	5	M	Bucket			

JR #	GUS #	Room	Area	Level	Plan	Depth	Status
JR60.95	2679	5	M	Bucket		508	
JR61.95	---	Md pollen		smallest pond			
JR62.95	---	Md pollen		smaller pond			
JR63.95	---	Md pollen		rocky N. face			
JR64.95	---	Md pollen					
JR65.95	---	Md pollen	V63				
JR65.5.95	---	Md pollen	pond	Bug trap d			
JR66.95	---	5	M-N	"seed"			
JR67.95	2723		AB	31	203		
JR68.95	2425	3	P	trough	177	547	Analysed
JR69.95	2296	btwn3,7 &5	Q	trash	163	590-585	
JR70.95	2297	btwn3,7 &5	Q	trash	163	575-580	
JR71.95	2728	btwn3,7 &5	Q	trash	163	573-568	
JR72.95	2727		Q	fireplace	194	538	Analysed
JR73.95	2456		P	cow manure	186	565	Analysed
JR74.95		16	S				
Sch7.3.15.							
1996	1996	1996	1996	1996	1996	1996	1996
JR1.96	2836	4			191	538	
JR2.96	2833	L.house	T	37	221		
JR3.96	2829	L.house	T	32	221		
JR4.96	2830	L.house	T	31	221		Analysed
JR5.69	2823	L.house	T	34	221		Analysed
JR6.96	2872	4	M	526	180		
JR7.96	2882	4a/19	M	2	191/232	544	
JR8.96	2195	23	V		231	596	
JR9.96	---	16	T	caprine			
JR10.96	2193	16	T		213	634	
JR11.96	---	16/7	T				Analysed
JR12.96	---	16	T				
JR13.96	---	16	T				Analysed

JR #	GUS #	Room	Area	Level	Plan	Depth	Status
JR14.96	---	seed sample	off site				
JR15.96	3032	22/25*	N		233	567	
JR16.96	3031	16	T		239	595	
JR17.96	3039	L.house	R		222	539	Analysed
JR18.96	3044	22	N		233	565	
JR19.96	2963		T		248	586	
JR20.96	---	16	T				Analysed
JR21.96	3214	23	V		231	581	
JR22.96	3215	23	U		236	571	
JR23.96	3229	23	V		231	562	
JR24.96	3216	L.house fire	Q		234	536	Analysed
JR25.96	3217	27	Z		171	587	
JR26.96	3297	25	N		250	545	
JR27.96	3264		R		222	524	
JR28.96	3218	19	J		260	582	
JR29.96	3353	19 post hole	J		260	602-590	
JR30.96	3361	13	Z		252	574	
JR31.96	3369		U	578	263	578	
JR32.96	3453	19			260	599	
JR33.96	3454	19				602	Analysed
JR34.96	3455	23	U		#6pg106	583	
JR35.96	3456	23	U		#6pg106	605-589	
Sch1.7.96.1	3151			21	238		
Sch1.7.96.2	3152	midden		19a	238		
Sch1.7.96.3	3153	twig strg		23a	238		
Sch1.7.96.4	3154	midden		19b	238		
Sch1.7.96.5	3155	twig strg		23b	238		
Sch1.7.96.6	3156	midden		19c	238		
Sch1.7.96.7	3157	L.house		39	238		
Sch1.7.96.8	3158	charcoal/caprine		35	238		Analysed
Sch1.7.96.9	3159	floor		38	238		

JR #	GUS #	Room	Area	Level	Plan	Depth	Status
Sch1.7.96.10	3160	wood chips		37	238		Analysed
Sch6.7.96.1	3164	25	N	grass	250	top 5 cm	
Sch6.7.96.2	3166	25	N	byre flr	250	bottom 5 cm	
Sch6.7.96.4	3165	25	N	lower flr	250		
Sch8.7.96.4	---			cow dung			
Sch6.7.96.3	3195	26	J	2	249		
Sch8.7.96.1	3167	27					Analysed
Sch8.7.96.2	---	23					
Sch29.6.96.2-4	3501	turf coil		42	238		
Sch2.7.96.11	---	flr layer			238		
Sch5.7.96.2	3503	midden 1			238	top 5 cm	
Sch5.7.96.3	3504	midden 1			238	middle	
Sch5.7.96.4	3505	midden1			238	bottom	
Sch5.7.96.5	3506	top of midden					
Sch5.7.96.6	3507	bottom midden					
Sch.8.7.96.4	---	cow					Analysed
Sch10.7.96.2	---	cow					Analysed

Appendix 4. SEM Photographic Documentation (X30) and Identification Criteria of GUS Macrofossils

The identification of the GUS macroremains was done predominately by comparing the archaeological material to modern reference material collected by Dr. Bent Fredskild, Botanical Museum, University of Copenhagen. Most of the remains were first identified during my time as a visiting researcher/student at the Natural Science Unit of the Danish National Museum. This provided me with the opportunity to have my identifications checked by more experienced researchers. The following are descriptions of the GUS macroremains. Taxa distributions are based on *The Flora of Greenland* (Böcher et al 1968). The seed shape terminology follows Berggren (1969); the surface detail terminology follows Montgomery (1977). Leaves and leaf buds are not described but leaf buds were photographed. Genera with only a single species in Greenland are identified to that species.

Heath/Outfield Group

Family: Betulaceae
Genus: *Alnus*
Species: *crispa*
Distribution: Isolated
Confirmed by: --
Description: Both *Alnus crispa* fruit and catkin scales were found. Fruit is elliptical to rhombic ca. 3- 4 mm long X 4 mm at the broadest point. Wings were broad, thin and translucent compared to the main section of the fruit. Remnants of two stigma were evident. Catkin is obtriangular, ca. 3- 4 mm at the top and ca. 1 mm at the bottom. The wide upper section appears layered. Qualitatively it is bark-like in appearances.

Family: Betulaceae
Genus: *Betula*
Species: *nana*
Distribution: Frequent, according to Fredskild 1991 no other *Betula* sp. is found in the area of the GUS site.
Confirmed by: --
Description: Both *Betula nana* fruit and catkin scales were found. Fruit is transversely elliptical, ca. 2 mm X 2 mm. Two stigma are usually evident. Wings are narrow and often absent. Catkin scales are qualitatively bark-like and the slight pubescence rarely evident in fossil material. Scales are slightly concave and generally the shape is obtriangular with the top divided into three finger-like section.

Family: Empetraceae
Genus: *Empetrum*
Species: *nigrum*
Distribution: Frequent, becoming less frequent in continental areas. Only one species in Greenland.
Confirmed by: B. Fredskild
Description: Nutlets were recovered these were triangular in cross section with the dorsal side rounded. On the ventral side the attachment protrudes slightly from the upper half. The plane shape was depressedly ovate (half moon) and ca. 2-2.5 mm X 1-1.3 mm. The surface detail is very rough and looks almost like sand grains or fine sand paper.

Family: Polygonaceae
Genus: *Polygonum*
Species: *viviparum*
Distribution: Frequent
Confirmed by: --
Description: Remains are depressedly obtriangular (ice cream cone shaped) and vary greatly in size from ca. 1.5 mm-4 mm X 1-2 mm. Modern samples are red in color but archaeological material are usually dark brown. There are two very distinct sections to the remain the lower cone segment shows bark- or wood-like surface details, occasionally linear cell pattern is visible running from top to bottom. The upper section is round in shape and the surface exhibits tiny circular or bump-like patterns.

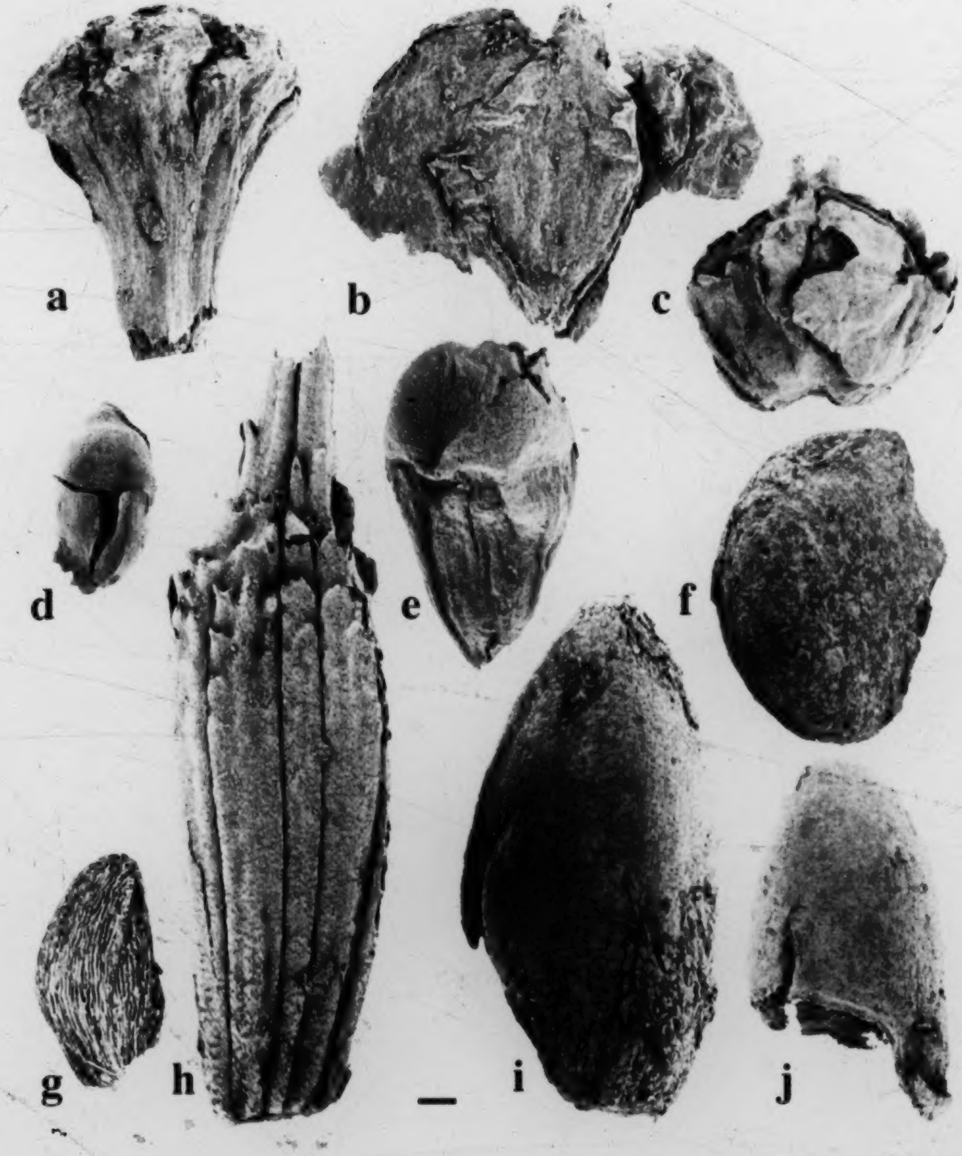
Family: Vacciniaceae
Genus: *Vaccinium*
Species: *vitis-idaea*
Distribution: Frequent, two other*Vaccinium* spespes are found in Greenland.*Vaccinium myrtillus* is found as isolated occurrences in areas closer to the Eastern Settlement. *Vaccinium uliginosum* is found through out Greenland but rare in the north.
Confirmed by: Genus confirmed by B. Fredskild.
Description: Seeds are elliptical ca. 0.5 mm X 1-1.3 mm. The three species are similar in appearances *V.vitis-idae*a differs from *V. myrtillus* by being more elliptical and less round and it differs from V.*uliginosum* in having a more distinctive reticulate (thin irregular brick-like) surface pattern.

Family: Juncaceae
Genus: *Luzula*
Distribution: Frequent.
Confirmed by: D. Robinson
Description: Seeds are elliptic, ca. 1- 1.3 mm X .05-.75 mm, with a distinctive tip. In my opinion fairly difficult to distinguish from some *Juncus* speices.

Family: Rosaceae
Genus: *Potentilla*
Species: *crantzii*
Distribution: Frequent- occasional

Confirmed by: --
Description: Seeds are depressedly ovate, ca. 1.- 1.5 mm X 1.8-2.1 mm, with a very distinct ribbed surface pattern. Style scar attachment is centrally positioned.

Family: Compositae
Genus: *Taraxacum*
Species: cf. *croceum*
Distribution: Frequent to rare, *T.croceum* occasional
Confirmed by: D. Robinson confirmed genus
Description: Seeds are narrowly ovate, ca. 3.5 -4.2 mm X 0.5 -1.0 mm, tapering to a beak. Surface is smooth to slightly ribbed for about 3/4 of its length. The top 1/4 is strongly ribbed to spiny.



SEM photographs of selected plant remains of the Heath/Outfield Group a) *Alnus crispa* catkin, b) *Alnus crispa*, c) *Betula nana*, d) *Luzula* sp., e) *Polygonum viviparum*, f) *Empetrum nigrum*, g) *Vaccinium vitis-idaea*, h) *Taraxacum* sp., i) leaf bud (*Salix* sp.), j) leaf bud (*Salix* sp.). Bar equals 100μm.

Wetland Group

Family: Cyperaceae
Genus:*Eriophorum*
Distribution: Restricted to moist ground - rare.
Confirmed by: A. Beaudoin
Description: Archaeological remains are in relatively poor condition. Seeds are narrowly obovate, ca. 1.5 mm X 0.5 mm, with a small tip on the top.

Family: Cyperaceae
Genus: *Carex* lenticular and trigonous morphotypes
Distribution: Frequent
Confirmed by: B. Fredskild
Description: *Carex* is a large category and to identify most *Carex* to species specific measurements are needed. A first step in classification was to distinguish between achenes that were lenticular in cross section from those that were trigonous.

Family: Oenotheraceae
Genus: *Epilobium*
Distribution: Rare - frequent, dependent on species
Confirmed by: A. Beaudoin
Description: Seeds are obovate, ca. 1.1 mm X 0.5 mm.

Family:Juncaceae
Genus: *Juncus*
Species: cf. *ranarius* or *arcticus* . References collection is not sufficient to make a distinction.
Distribution: Rare - frequent, depends on species
Confirmed by: --
Description: Seeds are elliptical, ca. 0.5 mm X 0.25 - 0.5 mm, with a distinctive tip

Ponds, Puddles Lake Margins Group

Family: Hippuridaceae
Genus: *Hippuris*
Species: *vulgaris*
Distribution: In lakes and ponds
Confirmed by: B. Fredskild
Description: Seeds are narrowly obovate, ca. 1.5-2 mm X 0.75 -1 mm. The seed has a hole to a centre which is partly hollow, a strong seam up one side and a surface which is smooth to rough depending on preservation and whether one is examining a wet or drying specimen. The surfaces has a sponge-like appearances.

Family: Ranunclaceae
Genus: *Ranunculus*
Species: *confervoides*
Distribution: Frequent in pools and lakes
Confirmed by: --
Description: Seeds are depressedly ovate, ca. 1.5 mm X 1 mm. with a transversely ribbed surfaces.

Family: Potomogetonaceae
Genus: *Potamogeton*
Distribution: Frequent
Confirmed by: D. Robinson
Description: Seeds are depressedly ovate, ca. 2.5 mm -1 mm, with a strong slightly protruding edge that becomes almost lip-like at the dorsal margin.

Apophyte Group

Family: Portulacaceae
Genus: *Montia*
Species: *fontana*
Distribution: Frequent, introduced
Confirmed by: D. Robinson
Description: seeds are broadly ovate, ca. 1 mm X 1 mm with a slightly asymmetrical end that shows a slight protrusion. Surface is glossy with concentric arrangement of small circular to ovate pits.

Family: Chenopodiaceae
Genus: *Chenopodium*
Species cf. *album*
Distribution: Frequent, introduced
Confirmed by: A. Beaudoin
Description: Seeds are broadly ovate, ca. 0.75 mm -0.75 mm, with a slightly open bottom, but this might be a damaged asymmetrical hilar end. The surface has very small almost speckled-like cell pattern and gives an overall impression of being smooth and moderately glossy.

Anthropochore Group

Family: Cruciferae
Genus: *Capsella*
Species: *bursa-pastoris*
Distribution: Introduced, isolated
Confirmed by: B. Fredskild
Description: Seeds are elliptic with a slight asymmetrical tip protruding. This tip is often slightly ripped. The surface cells look like small bricks, the surrounding ridges appear thickened and form spikes at intersections.

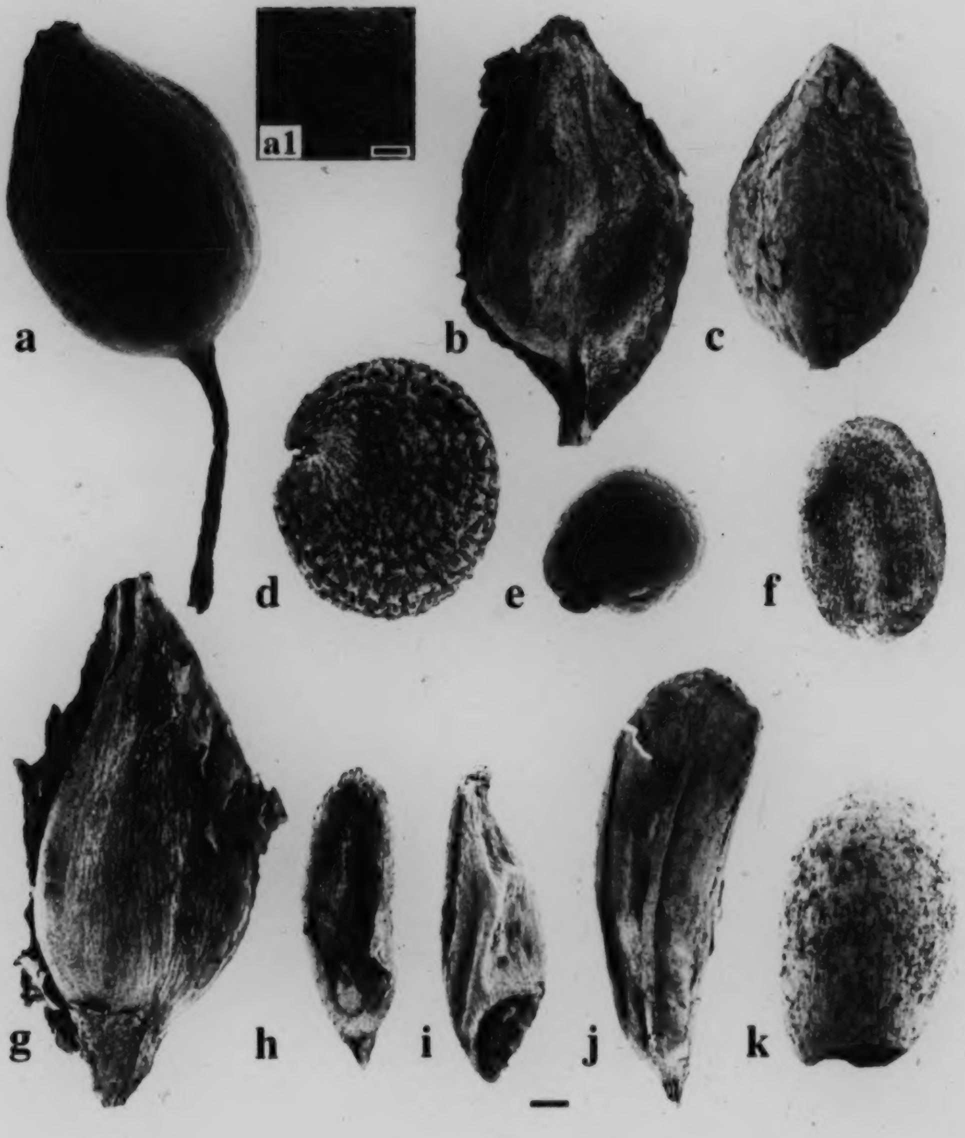
Family: Caryophyllaceae
Genus: *Stellaria*
Species: *media*
Distribution: Introduced
Confirmed by: B. Fredskild
Description: Seeds are broadly elliptical, ca. 1-1.2 mm X 1-1.2 mm, with a dense arrangement of papillose (being knob-like) on the surfaces.

Family: Polygonaceae
Genus: *Polygonum*
Species: cf. *aviculare*
Distribution: Introduced
Confirmed by: D. Robinson
Description: Seeds are trullate, ca. 2 -4.2 mm X 1- 2 mm, with the cross section trigonous, dark black but occasional has lighter surface covering preserved. Tip slightly flattened.

Grass Group

Family: Gramineae
Distribution: Frequent, dependent on Genus and spices.
Confirmed by: D. Robinson
Description: Only the first step toward genus identification was made, separating those seeds with a round hilum from those with a long hilum. Grass seeds are elliptic, ca. 3 - 8 X 1 -3 mm. many still had the glumes attached.

Family: Gramineae
Genus: *Poa*
Distribution: Frequent depends on species
Confirmed by: --
Description: Seeds are obovate. ca. 1- 1.2 mm 0.5-1m, with a round hilum



SEM photographs of selected plant remains of the Wetland, Ponds, Apophytes, Anthropochores and Grasses Groups. a) *Carex* sp. (lenticular), a1) Surface details, X270, Bar equals 60 µm, b) *Carex* sp. (lenticular), c) *Carex* sp. (trigonous), d) *Stellaria media*, e) *Montia fontana*, f) *Capsella bursa-pastoris*, g) *Polygonum aviculare*, h) Gramineae (round hilum), l) Gramineae (round hilum), j) Gramineae (elongated hilum), k) *Hippuris vulgaris*. Bar equals 100µm.

Miscellaneous

Family: Caryophyllaceae
Distribution: Frequencies depends on species
Confirmed by: D. Robinson
Description: This includes mostly poorly preserved or fragmented remains. The seeds are transversely to broadly elliptic in shape. Surface patterns are weakly to strongly ornate depending on species, most are rugose (wrinkled) papilla (knob like).

Family: Caryophyllaceae
Genus: *Cerastium*
Distribution: Frequencies depends on species
Confirmed by: --
Description: seeds are broadly elliptic, ca. 0.25 -0.75 mm X 0.25 -0.75 mm, surface structure consists of small papilla of varying density.

Family: Caryophyllaceae
Genus: *Miniuartia*
Distribution: Frequencies depends on species
Confirmed by: --
Description: Seeds are elliptic, ca. 0..5-0.75 mm X 0..5-0.75 mm, surface structure is moderate to strongly rugose.

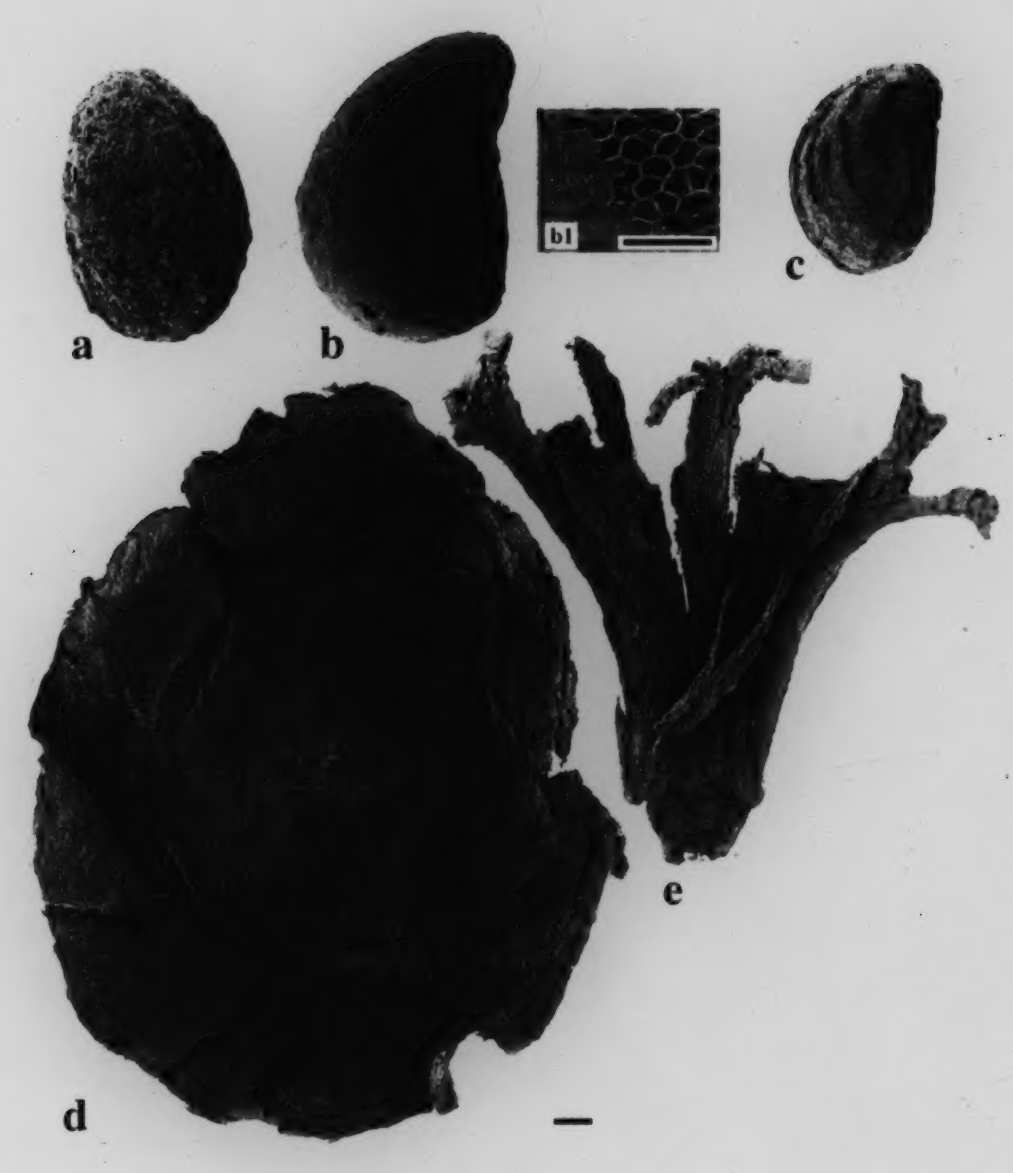
Family: Caryophyllaceae
Genus: *Silene*
Species: *acaulis* , Only one species in Greenland.
Distribution: Frequent
Confirmed by: --
Description: Seeds are elliptic, ca. 0.5-0.75 mm X 0.5 -0.75 mm, with very faint rugose surface pattern that appears to radiate from the center.

Family: Rosaceae
Genus: *Potentilla*
Species: *norvegica*
Distribution: Introduced
Confirmed by: --
Description: Seeds are depressedly ovate, ca. 0.5- 1 mm X 0.5-1.0 mm, with very distinct ribbed surface pattern. Style scar attachment is centrally positioned.

Family: Rosaceae
Genus: *Potentilla*
Distribution: Variable depending on species
Confirmed by: B. Fredskild.
Description: Seeds are depressedly ovate, ca. 1.0-1.9 mm X 0.8 -1.2 mm. Often found in halves, with a generally smooth surface and varying surface patterns but species could not be determined.

Family: Ranauculacea
Genus: *Ranunculus*
Distribution: Frequent depends on species
Confirmed by: B. Fredskild
Description: Seeds are broadly ovate, ca. 1-1.3 mm X 1-1.3 mm, often very light in colour, pale brown or yellow, beaks are occasionally present but often appear worn. When a seed is complete a mid ridge is often evident, seeds often split in half along middle ridge.

Family: Scrophulariaceae
Genus: *Rhinanthus*
Distribution: Occasional-frequent on grass slopes
Confirmed by: D. Robinson
Description: Seeds are very broadly ovate, ca. 1-4 mm X 2-5 mm, with a dark brown kidney shaped central section with translucent wings.



SEM photographs of selected plant remains from the Miscellaneous Group. a) *Ranunculus* sp., b) *Potentilla* sp., b1) Surface detail X500 Bar equals 60 µm, c) *Potentilla norvegica*, d) *Rhinanthus* sp., e) Unknown 'bract". Bar equals 100 µm.

Appendix 5. Macroremains and Pollen Counts for GUS Samples

Sample Number	3039	2830	3167	2823	3160
	JR17.96	JR4.96	Sch8.7.1	JR5.96	Sch1.7.10
	Rm27	Rm27	Rm27	Rm27	Rm27
HEATH/OUTFIELD	floor	floor	floor	floor	construction
Alnus crispa scale	2				3
Alnus crispa fruit	6				
Betula scale	2	4	12	5	3
Betula nana	21.2	16	22	5.1	13.2
Ericales					
Empetrum nigrum	1	5.2	2	1	1
Polygonum viviparum	2		0		
Salix sp					
Vaccinium	1	22.2	18.1	7.1	
Luzula sp	18.1	35.4	8.3	6.2	2.1
Juniperus communis					1
Leaf buds	30	0	112	31	35
Leaves	7	0	12		1
Potentilla crantzii					
Taraxacum (croceum)					
n=	**90.3**	**83.3**	**186.4**	**55.4**	**59.3**
WETLAND					
Cyperaceae	2		3		
Carex lentricular	16.4	108.3	16.4	12.4	3
Carex trigonous	203.2	207.3	25.2	24	19.1
Eriophorum		4			
Epilobium					
Juncus sp	12	49	10		3
n=	**222.1**	**320.1**	**45.1**	**36.4**	**22.1**
PONDS/PUDDLES....					
Hippuris vulgaris	2	5	3		1
Ranunculus confervoides					
Potamogeton sp					
Daphnia brood pouch	7	8		3	2
n=	**9**	**13**	**3**	**3**	**3**
APOPHYTES					
Montia fontana	1.2		1		
Chenopodium					
n=	**1.2**	**0**	**1**	**0**	**0**
ANTHROPOCHORES					
Capsella bursa-pastoris	67.1	26	11.1	62.4	12
Stellaria media	4		1		
Polygonum aviculare			0		
Polygonum convolvulus	1		1		
n=	**72.1**	**26**	**13.1**	**62.4**	**12**

Sample Number	3039	2830	3167	2823	3160
	JR17.96	JR4.96	Sch8.7.1	JR5.96	Sch1.7.10
	Rm27	Rm27	Rm27	Rm27	Rm27
Miscellaneous	floor	floor	floor	floor	construction
Caryophyllaceae	20.4	101.1	5	9.2	1
Cerastium sp					
Minuartia sp	3			1	
Silene	100	85	21.3	13	4
Ranunculus sp 1	4.1	0.2	3	2	1
Ranunculus(comments)					
Rosaceae					
Potentilla sp 1	1		1		1
Potentilla (comments)					1
Potentilla norvegica					
Rhinanthus sp					
Artemisia					
Fenostrate-Composite					
n=	**129**	**186.3**	**30.3**	**25.2**	**8**
GRASSES					
Gramineae					
Gramineae (round hilum)	127.1	8	72.3	16	18
Gramineae (elongate hilum)					
Poa sp					
n=	**127.1**	**8**	**72.3**	**16**	**18**
N=	**651.3**	**637.2**	**351.2**	**198.4**	**122.4**
Other					
Unknown	70	60	59	37	34
Lycopodium					
Eucalyptus					
Sclerotia					
Comments: includes possible identification	Triglochin		Thymus		"bracts"

Sample Number	3216	2727*	3264	2602	2484
	JR24.96	JR72	JR27.96	JR53b*	JR34
	Rm27	Rm27	Rm27	Rm 6	Rm 4a
HEATH/OUTFIELD	hearth	cooking pit	"grass"	floor	floor
Alnus crispa scale					
Alnus crispa fruit	5				
Betula scale		0	1	0	1
Betula nana	20.2	0.1	4.1	0	3
Ericales		0			1
Empetrum nigrum		1	1	0	46.2
Polygonum viviparum	✓	0	13	0	1
Salix sp		0		0	0
Vaccinium	15.1	2		0	72
Luzula sp	3.4	2.3	14.1	0	3
Juniperus communis		0			
Leaf buds	49	16.1	4	0	30
Leaves	2	1	5	0	2
Potentilla crantzii		0		0	0
Taraxacum (croceum)		0		0	0.1
n=	**95.2**	**22.5**	**42.2**	**0**	**159.3**
WETLAND					
Cyperaceae			2		
Carex lentricular	9	116.3	12.3	11	25.3
Carex trigonous	20.4	159.7	228.3	3	52.3
Eriophorum					
Epilobium					1
Juncus sp					
n=	**29.4**	**276**	**243.1**	**14**	**79.1**
PONDS/PUDDLES....					
Hippuris vulgaris		0.2		0	0.1
Ranunculus confervoides		0		0	0
Potamogeton sp		1		0	2
Daphnia brood pouch		3	1	0	1
n=	**0**	**4.2**	**1**	**0**	**3.1**
APOPHYTES					
Montia fontana		0	2.1	0	14.3
Chenopodium					2
n=	**0**	**0**	**2.1**	**0**	**16.3**
ANTHROPOCHORES					
Capsella bursa-pastoris	4	22.3	52.1	0	327
Stellaria media	4.2	5	1	0	170
Polygonum aviculare		0		0	0
Polygonum convolvulus		1		0	11.4
n=	**8.2**	**28.3**	**53.1**	**0**	**508.4**

Sample Number	3216	2727*	3264	2602	2484
	JR24.96	JR72	JR27.96	JR53b*	JR34
	Rm27	Rm27	Rm27	Rm 6	Rm 4a
Miscellaneous	hearth	cooking pit	"grass"	floor	floor
Caryophyllaceae		5		1	30.2
Cerastium sp		9		0	
Minuartia sp		0		0	6
Silene	15.2		8		3
Ranunculus sp 1	1	3.2	11	3	2.4
Ranunculus(comments)		1		0	0
Rosaceae					
Potentilla sp 1	1	7		0	9
Potentilla (comments)		6		0	0
Potentilla norvegica		0		0	0
Rhinanthus sp		0		0	13
Artemisia					
Fenostrate-Composite					
n=	**17.2**	**31.2**	**19**	**4**	**64.1**
GRASSES					
Gramineae					1
Gramineae (round hilum)	15.3	13	258.2	0	292.3
Gramineae (elongate hilum)		0		0	29
Poa sp		0		0	15
n=	**15.3**	**13**	**258.2**	**0**	**337.3**
N=	**165.3**	**375.2**	**619.2**	**18**	**1168.1**
Other					
Unknown	36		62	0	35
Lycopodium					
Eucalyptus					
Sclerotia					
Comments: includes possible identification	composite, "bracts"		slag		Potomogeton perfoliatus, Minitura grolandica

Sample Number	2266	2283	2267	2624	2604
	JR2*	JR3	JR1*	JR51*	JR55
	Rm4b	Rm 4a	Rm1	Rm19	Rm19
HEATH/OUTFIELD	floor	floor	floor	floor	Post hole 3/16
Alnus crispa scale					0
Alnus crispa fruit					0
Betula scale	1	0	0	0	3
Betula nana	2.1	0.3	3	0	23
Ericales					0
Empetrum nigrum	1	1	3.1	7	3.2
Polygonum viviparum	270.4	0	2	0	0
Salix sp		0	0	0	0
Vaccinium	7	2.3	3	95.3	36.2
Luzula sp	2	3.4	0	0	8.4
Juniperus communis					0
Leaf buds	21.2	31.1	0	48	43
Leaves	20.2	0	0	0	4
Potentilla crantzii	57.1	0	1	0	4
Taraxacum (croceum)	8.1	0	0	0	0.1
n=	**390.1**	**38.1**	**12.1**	**150.3**	**125.4**
WETLAND					
Cyperaceae					1
Carex lentricular	24.4	6.1	18	125	96.5
Carex trigonous	75	70.2	71	165.2	131.2
Eriophorum					0
Epilobium					0
Juncus sp				1	2
n=	**99.4**	**76.3**	**89**	**290.2**	**229.2**
PONDS/PUDDLES....					
Hippuris vulgaris	1	0	7.1	4	3.5
Ranunculus confervoides	1	0	1.3	1	0
Potamogeton sp	0	0	1	0	1
Daphnia brood pouch	9	8	12	3	21
n=	**11**	**8**	**21.4**	**8**	**25.5**
APOPHYTES					
Montia fontana	255	13.1	7.4	1.4	2.2
Chenopodium					0
n=	**255**	**13.1**	**7.4**	**1.4**	**2.2**
ANTHROPOCHORES					
Capsella bursa-pastoris	1648.3	226.3	118.2	61.2	98.8
Stellaria media	508	44	48	294	30.2
Polygonum aviculare			0	0	0
Polygonum convolvulus	9	5	0	11.2	1
n=	**2165.3**	**275.3**	**166.2**	**366.4**	**130**

Sample Number	2266	2283	2267	2624	2604
	JR2*	JR3	JR1*	JR51*	JR55
	Rm4b	Rm 4a	Rm1	Rm19	Rm19
Miscellaneous	floor	floor	floor	floor	Post hole 3/16
Caryophyllaceae	9.2	7	18	4	15
Cerastium sp			3		14
Minuartia sp		0	0	1	0
Silene	5	7	3	7	14
Ranunculus sp 1	15	2.2	15.3	43.2	13.7
Ranunculus(comments)	2		7	8.3	0
Rosaceae					0
Potentilla sp 1	68	11	6.3	15.3	9.7
Potentilla (comments)		0	6	0	6
Potentilla norvegica		0	0	0	0
Rhinanthus sp	37.3	3	0	0	2.1
Artemisia					0
Fenostrate-Composite					0
n=	**137**	**30.2**	**59.1**	**79.3**	**75**
GRASSES					
Gramineae					0
Gramineae (round hilum)		123	41.1	64	112.3
Gramineae (elongate hilum)		4	2	12	4
Poa sp		2	0	0	14
n=	**0**	**129**	**43.1**	**76**	**130.3**
N=	**3057.8**	**570**	**398.3**	**972.1**	**718.1**
Other					
Unknown	2	23	12	10	
Lycopodium					
Eucalyptus					
Sclerotia					
Comments: includes possible identification			P. tridenta and others, R reptanus, r.hyperboreus	cf campanula, legnminosae	

Sample Number	2417	2450	2544	2470	2424
	JR37	JR27*	JR24	JR26*	JR32
	unknown	Rm 7	Rm 3	Rm 3	Rm 3
HEATH/OUTFIELD	floor	floor	floor	floor	floor
Alnus crispa scale					
Alnus crispa fruit					
Betula scale	1	0	3	4	0
Betula nana		4	2.1	15	4
Ericales					
Empetrum nigrum	4	5	2	1	2
Polygonum viviparum	1	0	0	3.1	3.1
Salix sp	0	0	0	0	
Vaccinium	8	53	9	8.2	5.4
Luzula sp	6.3	5	4	0	1.2
Juniperus communis					
Leaf buds	19	105	10	133	31.1
Leaves	2	1	0	14.3	2.1
Potentilla crantzii		1		3	
Taraxacum (croceum)	0.1	0	1.1	0.2	0.2
n=	**41.4**	**174**	**31.2**	**182.4**	**49.1**
WETLAND					
Cyperaceae					
Carex lentricular	17.3	64	6	13.5	24.1
Carex trigonous	35.1	155.1	16.1	132.4	59
Eriophorum					
Epilobium					
Juncus sp				1	
n=	**52.4**	**219.1**	**22.1**	**147.4**	**83.1**
PONDS/PUDDLES....					
Hippuris vulgaris	0	9	0	0.3	0
Ranunculus confervoides	0	0.3	0	2	0
Potamogeton sp	0	0	0	0	0
Daphnia brood pouch	5	10	12	10	11
n=	**5**	**19.3**	**12**	**12.3**	**11**
APOPHYTES					
Montia fontana	2.4	2.1	2.4	55	25.2
Chenopodium				1	
n=	**2.4**	**2.1**	**2.4**	**56**	**25.2**
ANTHROPOCHORES					
Capsella bursa-pastoris	177.4	247	120.3	1272.2	1577.3
Stellaria media	19.3	60.1	29.3	262.1	116
Polygonum aviculare		0			
Polygonum convolvulus	1	0	0.1	2.3	0
n=	**198.2**	**307.1**	**150.2**	**1536.6**	**1693.3**

Sample Number	2417	2450	2544	2470	2424
	JR37	JR27*	JR24	JR26*	JR32
	unknown	Rm 7	Rm 3	Rm 3	Rm 3
Miscellaneous	floor	floor	floor	floor	floor
Caryophyllaceae	6.4	0	4	3	20
Cerastium sp	3		0	0	12.2
Minuartia sp	6	0	0	0	0
Silene		11			
Ranunculus sp 1	5	0.3	79.3	7.4	5.1
Ranunculus(comments)		1			
Rosaceae					
Potentilla sp 1	16.1	8.3	2.4	19	9
Potentilla (comments)	0	0	0	1	
Potentilla norvegica	1	0	0	0	
Rhinanthus sp	1	0	0	11.6	13.1
Artemisia					
Fenostrate-Composite					
n=	**39**	**21.1**	**86.2**	**42**	**59.4**
GRASSES					
Gramineae				4	
Gramineae (round hilum)	140.1	115.4	29.1	478.1	220.4
Gramineae (elongate hilum)	7.1	30	3.2	46.3	39.1
Poa sp	7	6	3	0	10
n=	**154.2**	**151.4**	**35.3**	**528.4**	**270**
N=	**493.5**	**894.1**	**339.4**	**2505.1**	**2191.1**
Other					
Unknown	0	60		104	0
Lycopodium					
Eucalyptus					
Sclerotia					
Comments: includes possible identification			Thymus, Arctostaphylos		

Sample Number	2610	2609	2425	2463	2464	2465
	JR50	JR52	JR68	JR17	JR18	JR19
	Rm 3	Rm 3	Rm 3	Rm 3	Rm 3	Rm 3
HEATH/OUTFIELD	floor	floor	trough	floor	floor	floor
Alnus crispa scale						
Alnus crispa fruit						
Betula scale	0	19	0			
Betula nana	0	4	16	63	54	31
Ericales				1	1	
Empetrum nigrum	0	2.1	4			
Polygonum viviparum	1	7	18.2			
Salix sp	0	0	0	8	11	31
Vaccinium	9.2	4	10			
Luzula sp	5.3	5	3			
Juniperus communis						
Leaf buds	23	27.1	0			
Leaves	0	0	0			
Potentilla crantzii			4			
Taraxacum (croceum)	0.1	1	7			
n=	**39.1**	**69.2**	**62.2**	**72**	**66**	**62**
WETLAND						
Cyperaceae	1		2	10	1	6
Carex lentricular	11	35.4	10			
Carex trigonous	38.4	69.4	32.1			
Eriophorum						
Epilobium						
Juncus sp						
n=	**50.4**	**105.3**	**44.1**	**10**	**1**	**6**
PONDS/PUDDLES....						
Hippuris vulgaris	0	0	1			
Ranunculus confervoides	0	0	0			
Potamogeton sp	0	0	0			
Daphnia brood pouch	4	1	3			
n=	**4**	**1**	**4**	**0**	**0**	**0**
APOPHYTES						
Montia fontana	0.2	0.1	34.3			
Chenopodium						
n=	**0.2**	**0.1**	**34.3**	**0**	**0**	**0**
ANTHROPOCHORES						
Capsella bursa-pastoris	570.3	97.4	582.3			
Stellaria media	20	35.2	214.4			
Polygonum aviculare						
Polygonum convolvulus	4.1	1	2.3			
n=	**594.4**	**134.1**	**799**	**0**	**0**	**0**

Sample Number	2610	2609	2425	2463	2464	2465
	JR50	JR52	JR68	JR17	JR18	JR19
	Rm 3	Rm 3	Rm 3	Rm 3	Rm 3	Rm 3
Miscellaneous	floor	floor	trough	floor	floor	floor
Caryophyllaceae	1.4	18	20.3	2	1	3
Cerastium sp	0	0	0			
Minuartia sp	0	0	0			
Silene						
Ranunculus sp 1	17.3	1	15.2			
Ranunculus(comments)			0			
Rosaceae					1	
Potentilla sp 1	13.5	12.2	3.2			
Potentilla (comments)	0	0				
Potentilla norvegica	0	1	0			
Rhinanthus sp	12.3	7.4	31.3			
Artemisia				7	13	19
Fenostrate-Composite				7	6	3
n=	**45**	**40.1**	**70**	**16**	**21**	**25**
GRASSES						
Gramineae						
Gramineae (round hilum)	509.4	11.3	402.3	7		12
Gramineae (elongate hilum)	52.3	20.1	20			
Poa sp	0	0	16			
n=	**562.2**	**31.4**	**438.3**	**7**	**0**	**12**
N=	**1295.3**	**381.2**	**1451.9**	**105**	**88**	**105**
Other						
Unknown	22	26	42	3	17	17
Lycopodium				7	1	4
Eucalyptus				3	0	2
Sclerotia						
Comments: includes possible identification	cf: pine,artostaphlus	Thymus		Pollen	Pollen	Pollen

Sample Number	3264	JR13.96	JR9.96	3297	3158
	JR27.96	Rm16	Rm16	JR26 .96	Sch1.7.96.8
	caprine	caprine	caprine	caprine	caprine
HEATH/OUTFIELD	10 pellets			Rm25	Rm27
Alnus crispa scale					
Alnus crispa fruit		4		6	2
Betula scale					
Betula nana		65	3	118	44
Ericales			3		
Empetrum nigrum					
Polygonum viviparum					
Salix sp		18	12	15	3
Vaccinium					
Luzula sp	1				
Juniperus communis					
Leaf buds					
Leaves					
Potentilla crantzii					
Taraxacum (croceum)					
n=	**1**	**87**	**18**	**139**	**49**
WETLAND					
Cyperaceae		5			1
Carex lentricular					
Carex trigonous	2				
Eriophorum					
Epilobium					1
Juncus sp					
n=	**2**	**5**	**0**	**0**	**2**
PONDS/PUDDLES....					
Hippuris vulgaris					
Ranunculus confervoides					
Potamogeton sp					
Daphnia brood pouch					
n=	**0**	**0**	**0**	**0**	**0**
APOPHYTES					
Montia fontana					
Chenopodium					
n=	**0**	**0**	**0**	**0**	**0**
ANTHROPOCHORES					
Capsella bursa-pastoris					
Stellaria media					
Polygonum aviculare					
Polygonum convolvulus					
n=	**0**	**0**	**0**	**0**	**0**

Sample Number	3264	JR13.96	JR9.96	3297	3158
	JR27.96	Rm16	Rm16	JR26 .96	Sch1.7.96.8
	caprine	caprine	caprine	caprine	caprine
Miscellaneous					
Caryophyllaceae	2			3	1
Cerastium sp					
Minuartia sp					
Silene					
Ranunculus sp 1					
Ranunculus(comments)					
Rosaceae					
Potentilla sp 1					
Potentilla (comments)					
Potentilla norvegica					
Rhinanthus sp					
Artemisia		8	15	24	3
Fenostrate-Composite					
n=	**2**	**8**	**15**	**27**	**4**
GRASSES					
Gramineae		8	16	7	2
Gramineae (round hilum)					
Gramineae (elongate hilum)					
Poa sp					
n=	**0**	**8**	**16**	**7**	**2**
N=	**5**	**108**	**49**	**173**	**57**
Other					
Unknown	6	16	8	18	25
Lycopodium					
Eucalyptus		11			18
Sclerotia					
Comments: includes possible identification		Pollen	Pollen	Pollen	

Sample Number	3229	2586	2586	Sch.8.7.96.4	Sch10.7.96.2	2456
	JR23.96	JR46	JR46			JR73
	caprine	caprine	caprine	Rm4/cow	cow	cow
HEATH/OUTFIELD	Rm23					
Alnus crispa scale						
Alnus crispa fruit	1			2		
Betula scale		0			11	
Betula nana	29	4	2	11		
Ericales	3					
Empetrum nigrum		0.1				
Polygonum viviparum		0				
Salix sp	25	0		5	27	
Vaccinium		1				
Luzula sp		0.3				
Juniperus communis						
Leaf buds		0				
Leaves		2				
Potentilla crantzii		0				
Taraxacum (croceum)		0				
n=	**58**	**7.4**	**2**	**18**	**38**	**0**
WETLAND						
Cyperaceae	8		1	5	3	
Carex lentricular		3				
Carex trigonous		22.2				
Eriophorum						
Epilobium						
Juncus sp						
n=	**8**	**25.2**	**1**	**5**	**3**	**0**
PONDS/PUDDLES....						
Hippuris vulgaris		0				
Ranunculus confervoides		0				
Potamogeton sp		0				
Daphnia brood pouch		0				
n=	**0**	**0**	**0**	**0**	**0**	**0**
APOPHYTES						
Montia fontana		0				
Chenopodium						
n=	**0**	**0**	**0**	**0**	**0**	**0**
ANTHROPOCHORES						
Capsella bursa-pastoris		4.1				
Stellaria media		0				
Polygonum aviculare	1	0				
Polygonum convolvulus	10	0				
n=	**11**	**4.1**	**0**	**0**	**0**	**0**

Sample Number	3229	2586	2586	Sch.8.7.96.4	Sch10.7.96.2	2456
	JR23.96	JR46	JR46			JR73
	caprine	caprine	caprine	Rm4/cow	cow	cow
Miscellaneous						
Caryophyllaceae		0	2	4	2	
Cerastium sp		0				
Minuartia sp		0				
Silene						
Ranunculus sp 1		1.1				
Ranunculus(comments)		0				
Rosaceae	2			2		
Potentilla sp 1		1				
Potentilla (comments)		0				
Potentilla norvegica		0				
Rhinanthus sp		0				
Artemisia	21			1	16	
Fenostrate-Composite						
n=	**23**	**2.1**	**2**	**7**	**18**	**0**
GRASSES						
Gramineae	10		5	55	41	
Gramineae (round hilum)		7.3				0.3
Gramineae (elongate hilum)		0				
Poa sp		0				
n=	**10**	**7.3**	**5**	**55**	**41**	**0.3**
N=	**110**	**46.1**	**10**	**85**	**100**	**0.3**
Other						
Unknown	20		4	14	12	0
Lycopodium	3			18	4	
Eucalyptus			1		3	
Sclerotia						
Comments: includes possible identification	Pollen		Pollen	Pollen	Pollen	

Sample Number	3454	cow dung	2618	2319	2343	2334
	JR33.96	JR20.96	JR49	JR9	JR16*	JR10*
	Rm19/cow	Rm16/cow	peat	turf	peat	fill
HEATH/OUTFIELD						
Alnus crispa scale						
Alnus crispa fruit	2					
Betula scale			0	0	0	7
Betula nana	31	72	0	2	0	17
Ericales	1					
Empetrum nigrum			0	1	11	1.4
Polygonum viviparum			0	0	0	0
Salix sp	8	6	0	0	0	0
Vaccinium			0	1	4	7.1
Luzula sp			0	3.4	0	0
Juniperus communis						
Leaf buds			13	29	7.4	116.2
Leaves			3	0	0	2
Potentilla crantzii			0	0		
Taraxacum (croceum)			0	0	0	0
n=	**42**	**78**	**16**	**36.4**	**22.4**	**151.2**
WETLAND						
Cyperaceae						0.2
Carex lentricular			2	14	6.1	50.4
Carex trigonous			1	105.4	12.2	90.4
Eriophorum						
Epilobium						
Juncus sp			1			2
n=	**0**	**0**	**3**	**119.4**	**18.3**	**141**
PONDS/PUDDLES....						
Hippuris vulgaris			0	1	2.3	9.1
Ranunculus confervoides			0	0	3	0
Potamogeton sp			0	0	0	1
Daphnia brood pouch			1	32	0	5
n=	**0**	**0**	**1**	**33**	**5.3**	**15.1**
APOPHYTES						
Montia fontana			0	8.4	3.2	5.3
Chenopodium						
n=	**0**	**0**	**0**	**8.4**	**3.2**	**5.3**
ANTHROPOCHORES						
Capsella bursa-pastoris			4	246.4	5.1	144
Stellaria media			0	86	0	41.1
Polygonum aviculare			0	0		
Polygonum convolvulus			0	0.2	0	2.1
n=	**0**	**0**	**4**	**333.1**	**5.1**	**187.2**

Sample Number	3454	cow dung	2618	2319	2343	2334
	JR33.96	JR20.96	JR49	JR9	JR16*	JR10*
	Rm19/cow	Rm16/cow	peat	turf	peat	fill
Miscellaneous						
Caryophyllaceae	2	1	4.1	25.1	5.1	1
Cerastium sp			0		0	12.1
Minuartia sp			0	0	0	0
Silene				5		
Ranunculus sp 1			0.3	13.3	4.1	25
Ranunculus(comments)			0	0	0	
Rosaceae		4				
Potentilla sp 1			0	2.4	3	9
Potentilla (comments)			0	0	0	0
Potentilla norvegica			0	0	0	0
Rhinanthus sp			0	1	0	0
Artemisia	10					
Fenostrate-Composite						
n=	**12**	**5**	**4.4**	**47.3**	**12.2**	**47.1**
GRASSES						
Gramineae	43	21				
Gramineae (round hilum)			9	62.3	1	72
Gramineae (elongate hilum)			0	1	0	0
Poa sp			0	2	4	7
n=	**43**	**21**	**9**	**65.3**	**5**	**79**
N=	**97**	**104**	**37.4**	**643.4**	**72**	**626.4**
Other						
Unknown	9	13	6	33	0	33
Lycopodium		1				
Eucalyptus	2	12				
Sclerotia			present	present		
Comments: includes possible identification	Pollen	Pollen		P. tridenta		

Appendix 6. Common English, Danish and Greenlandic Names for Plant Found at GUS

The English, Danish and Greenlandic names are as close as possible when a plant is not identified to species level.

Latin	English	Danish	Greenlandic
Heath/Outfield			
Alnus crispa	green alder	bejerg-el	nunangiak imalt. palleq
Betula nana	dwarf birch	dværg-birk	avaalaqiaq
Ledum sp.	labrador tea	mose post	qajaasaq
Empetrum nigrum	crowberry	fjeld revling	paarnaqutit
Polygonum viviparum	knotweed	topspirende pileurt	quperluusap naanii imalt. pukulungissat
Salix sp.	willow	pil	orpigaq imalt. seeq
Vaccinium vitis-idaea	rock cranberry	tyttebær	kimmernat
Luzula sp.	---	frytle	---
Juniperus communis	juniper	fjeld-ene	kakillarnaq imalt. paarnaqulluk
Potentilla crantzii	Alpine cinquefoil	Guld potentil	inneruulaaraq
Taraxacum sp.	dandelion	mælkebøtte	---
Wetland			
Carex sp.	sedge	star	ivigaasaq
Eriophorum sp.	cotton grass	kæruld	ukaliusaq
Epilobium sp.	willow herb	-dueurt	---
Juncus sp.	rush	-sive	ivissuaq
Ponds/Puddles.....			
Hippuris vulgaris	common mare's tale	hestehale	tasiup naanii
Potamogeton sp.	pondweed	vandaks	---
Ranunculus confervoides	---	drærg-vandranunkel	--- ---
Apophytes			
Montia fontana	blinking chickweed	stor vandarve	---
Chenopodium	goosefoot	---	---

Latin	English	Danish	Greenlandic
Anthropochores			
Capsella bursa-pastoris	shephard's purse	- - -	- - -
Stellaria media	chickweed	- - -	- - -
Polygonum aviculare	knotgrass	- - -	- - -
Ranunculus sp.	buttercup	ranunkel	sungaartuaraq
Potentilla sp.	cinquefoil	potentil	- - -
Polygonum convolvulus	- - -	- - -	- - -
Thymus	thyme	skotsk timian	tupaarnaq
Artemisia	wormwood	bynke	- - -
Grasses			
Gramineae	grass	græs	- - -
Miscellaneous			
Cerastium sp.	- - -	hønsetarm	- - -
Minuartia sp.	sandwort	norel	- - -
Silene	catchfly/campion	- - -	- - -
Potentilla norvegica	Norwegian cinquefoil	- - -	- - -
Rhinanthus	yellow rattle	nordisk skaler	uummataasaq

The Latin nomnclature follow Böcher *et al.* 1968, the English common names follow Feilberg *et al.* 1984 and Fitter *et al.* 1974, the Danish common names follow Feilberg *et al.* 1984 and Foersom *et al.* 1982 and the Greenlandic common names follow Foersom *et al.* 1982 .

Appendix 7. Guidelines for Interpreting Paleoethnobotanical Assemblages.

1) "By considering charred seeds as prehistoric and uncharred as modern, unless there is reason to believe otherwise, some prehistoric patterns *may* be lost. However to do other wise will *definitely* increase the "noise" in the archaeological seed assemblage due to the potentially large number of seeds found naturally in soils"(Minnis 1981:147).
This idea of emphasizing only carbonized seed assemblages has been reinforced by other researchers (Lennstrom and Hastof 1995; Miksicek 1987). The two exceptions, to this are intestinal contents and fecal material.

2) Noncarbonized seeds introduces too much "noise" into a paleoethnobotanical assemblages making patterns obscure (Green 1982; Minnis 1981).

3) Plant remains are carbonized either as a result of human behavior or natural fires, in either way the record is biased (Green 1982; Hally 1981; Munson *et al.* 1971; Wilson 1984).

4) Directly used plants will have a better chance of being preserved if they require processing by fire. For example, grain that requires parching such as emmer is more likely to be found than grain released during free threshing of wheat (Dennell 1976).

5) No direct correlation can be made between the quantity of a plant remains and its economic importance at the time the archaeological site was inhabited (Begler and Keatinge 1979; Dennell 1976; Munson *et al.* 1971).

6) The fact that edible plant remains occur does not mean they were eaten or used (Begler and Keatinge 1979; Dennell 1976).

7) Edible plants will not always survive to be found in the archaeological record (Munson *et al.* 1971; Dennell 1976).

8) Plant macrofossils that are economically important will be found in specific features such as storage, processing or consumption areas (Dennell 1976).

9) Many of the plant remains found in middens are likely to be those considered by the culture as unimportant (Dennell 1976).

10) Non-cultural sediments must be sampled for comparative purposes to determine if patterns from cultural sediments are "real"(Dennell 1976; Lennstrom and Hastof 1995; Miller and Gleason 1994; Minnis 1981).

Appendix 8. Plants Identified in GUS Samples with Known Anthropogenic Uses.

Plant	Part	Use	Sources
Heath/Outfield			
Alnus crispa	twigs	roofing material, fodder	
Betula nana	twigs	roofing material leaf fodder	Roussell 1941 Rasmussen 1993
Ledum sp.	leaves	tea	Usher 1974
Empetrum nigrum	ripe fruit	edible berry, Wine	Harris 1968, McGovern 1983
Polygonum viviparum	roots	eaten as vegetable	Usher 1974
Salix spp.		floor covering	Roussell 1941
Vaccinium vitis-idaea	ripe fruit	jams, jellies, dye	Usher 1974
Luzula spp.		floor covering	Buckland *et al.* 1983
Juniperus communis	ripe fruit branches	seasoning, floor covering	Usher 1974, Roussell 1941
Potentilla crantzii			
Taraxacum spp	leaves	used as a leafy green	Harris 1968
Wetland			
Carex spp.		fodder, floor covering	Fredskild 1981
Eriophorum	perianth	wick in oil lambs	Dimbley 1978
Epilobium	leaves	tea	Usher 1974
Juncus spp.		Floor covering	Buckland *et al.* 1983
Ponds/Puddles.....			
Hippuris vulgaris	young leaves	edible	Usher 1974
Apophytes			
Montia fontana	leaves	edible	Usher 1974
Anthropochores			
Capsella bursa-pastoris	leaves, fruit	diuretic, medicinal	Usher 1974
Stellaria media	upper leaf	salad greens	Usher 1974
Polygonum aviculare	closed flower	used as a meal, flour	Usher 1974 McGovern *et al.* 1983
Ranunculus spp.		fodder	Greig 1984
Potentilla spp.		species of this genus are often used as teas, medicinaly, dye	Usher 1974
Thymus		seasoning	Harris 1968
Artemisia	leaves	used to flavor pork and goose	Usher 1974
Grasses			
Gramineae		fodder, floor covering grasses can be consumed by people if prepared correctly	Fredskild and Humle 1991, Harris 1968